FLIGHT
and
The AIRCRAFT ENGINEER

First Aeronautical Weekly in the World : Founded 1909

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Editorial, Advertising and Publishing Offices: DORSET HOUSE, STAMFORD STREET, LONDON, S.E.1
Telegrams: Truditur, Sedist, London. Telephone: Waterloo 3333 (35 lines).

8-10, CORPORATION ST., COVENTRY. *Telegrams:* Autocar Coventry. *Telephone:* Coventry 5210.
GUILDHALL BUILDINGS, NAVIGATION ST., BIRMINGHAM, 2. *Telegrams:* Autopress, Birmingham. *Telephone:* Midland 2971 (5 lines).
260, DEANSGATE, MANCHESTER, 3. *Telegrams:* Iliffe, Manchester, *Telephone:* Blackfriars 4412.
268, RENFIELD ST., GLASGOW, C.2. *Telegrams:* Iliffe, Glasgow. *Telephone:* Central 4857.

SUBSCRIPTION RATES: Home and Abroad: Year, £2 8 0. 6 months, £1 4 0. 3 months, 12s. 0d.

Registered at the G.P.O. as a Newspaper.

No. 1668. Vol. XXXVIII. DECEMBER 12, 1940 Thursdays, Price 9d.

The Outlook

Gallant Blenheims

IN this week's instalment of the "War in the Air" the story is told of how three Blenheims were sent out to cut the Italian communications in the rear of Koritza, and of how they demolished a vital bridge, though only one of the three came back. It recalls the story of the bridge in Holland, the destruction of which earned posthumous Victoria Crosses for the crew of the leading bomber. Apart from the gallantry of the airmen concerned in the exploit, this feat in Albania may well go down to history as a classic example of the effect which clever use of bombers may have on an important battle. The Greek General Staff had explained the situation to the R.A.F. Their troops were threatening Koritza and the Italians were hurrying up reinforcements. If those new troops could be delayed, it might make all the difference to the Greek attack. The R.A.F. took on the job.

Albania is a country of few roads, and so far as one can see from the maps available, if that one road were efficiently cut it would be absolutely impossible for the Italian supports to get through at all. The Blenheims destroyed an important bridge on that road, and the surviving crew was able to report that the destruction was complete. It seems a fair inference that this bomb settled the fate of Koritza, which the Greeks entered six days later.

That bomb may well have been the most important turning point in the campaign, and it is pleasant to think that the R.A.F. in Greece, though its numbers cannot be large, have been able to give such very effective help to an Army which has surprised the world by its gallantry.

We may hope that some at least of the crews of the two missing Blenheims have survived as prisoners of war.

Food for Thought

FLIGHT is privileged to publish in this special issue an article by Mr. Sydney Camm, a director and chief designer of Hawker Aircraft, Ltd. It is most appropriate that he should take the opportunity of our annual review of British aircraft to look ahead and to try to visualise the lines along which development is likely to run.

No designer takes a more realistic view of aircraft design than does Mr. Camm. We cannot remember one occasion during his long career on which he was led seriously astray by some attractive-looking scheme which afterwards turned out to be so full of minor snags that they outweighed the fundamental advantages. Yet he certainly cannot be accused of not taking the long view. Rather is the explanation of his success to be found in the fact that he looks farther ahead than most, and what is perhaps more important, his estimate of details in relation to the whole is uncannily accurate. To realise that this is so, one need only remember that the Hurricane was designed some seven years ago. Yet there is no single-seater fighter in the world to-day to beat it.

It is on this background that our readers should study Mr. Camm's article in this issue. Among so much wisdom it is difficult to pick out any particular item as being the outstanding pearl, but, personally, we are impressed by the reference to choice of materials, and by the attention called to the importance of the space occupied by the structure. That is an aspect which is often overlooked, although it is obvious enough, once it is pointed out. There is so much gear to be stowed inside a wing that every cubic inch counts. The high-tensile steel scores there because it takes up the least space. At the other end of the scale one might quote the Wright monoplane which was entered for the Gordon Bennett Race at Etampes, France, some twenty years ago. In

that the entire space between spars, and in the leading edge, was filled with balsa wood which took the place of girder ribs in supporting the plywood skin. That provides a rather good illustration of Mr. Camm's argument.

Ad Astra

ON one aspect Mr. Camm's article and that by Mr. Pemberton-Billing touch the same point · the influence of altitude on design and the question of supercharging. It would appear that for maximum efficiency we shall, whether we like the complication or not, have to develop not only the multi-gear supercharger but also the multi-gear, and possibly multi-blade, airscrew.

In last week's issue we described and illustrated the new Rotol four-blader, which seems to solve one of the problems. Two-speed blowers are already in use on some engines, but the combination of multi-gear blowers and multi-gear airscrews presents a number of problems which will cause many headaches before they are solved.

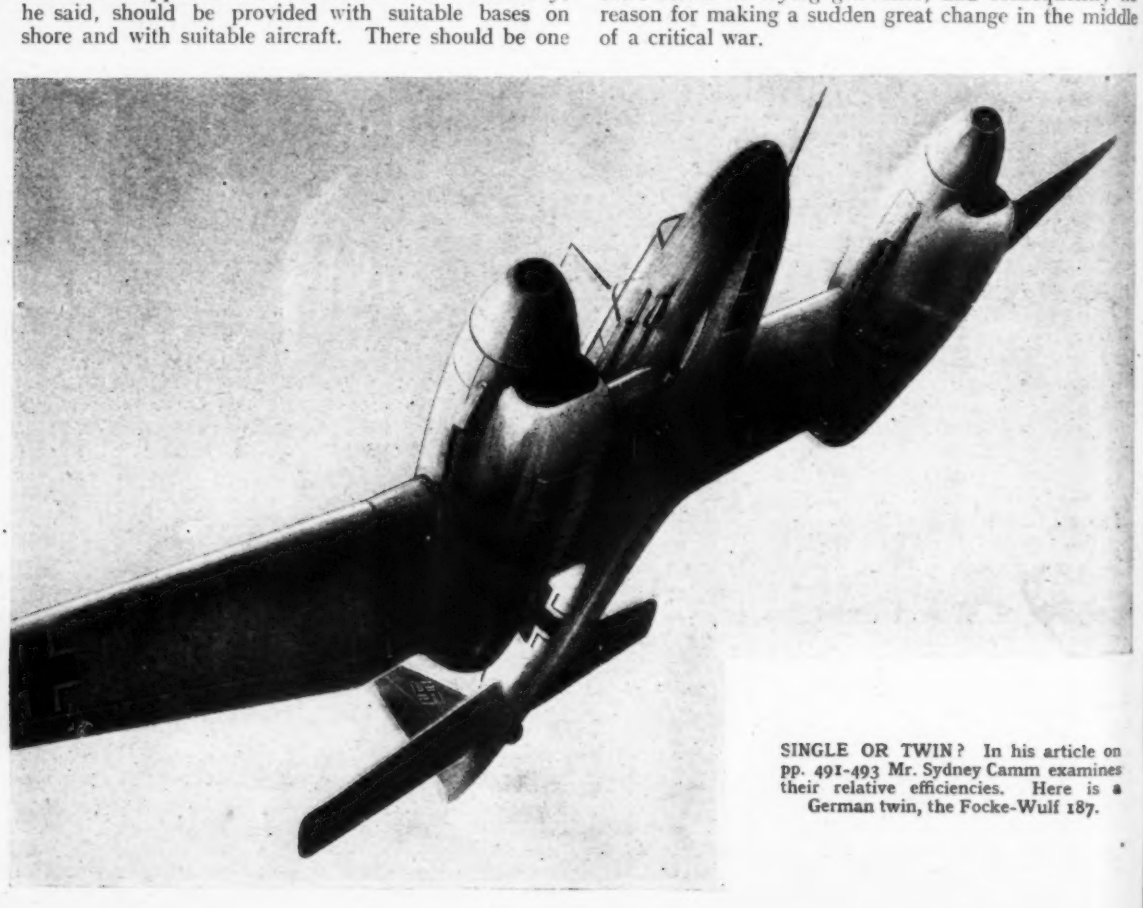
Mr. Camm examines the old problem of single or twin engines. He seems, on the whole, to come to the conclusion that for sheer efficiency the single has it. With that conclusion few will quarrel, but it *is* possible to argue that the twin can be made faster in spite of its higher drag, merely by virtue of the greater power. (Mr. Camm compares two machines *with the same* power.) The one may be efficient, but the other will be effective.

Sea Reconnaissance

IN Parliament the other day Commander Sir Archibald Southby spoke about the enemy menace to our shipping, saying that the most vital thing was to protect the western approaches to the British Isles. The Navy, he said, should be provided with suitable bases on shore and with suitable aircraft. There should be one authority to guard the western approaches, and, as this was a naval matter, a naval officer should be in control. These words, in effect, are a demand that at least part of the Coastal Command should be handed over in some way to the Admiralty. The gallant Commander did not specify in what way this ought to be done. He did not suggest or demand that the whole of the Coastal Command should be handed over to the Admiralty on the lines of the Fleet Air Arm, and he did not use the phrase "Give the Navy operational control" over the reconnaissance aircraft which flew over the western approaches, so we cannot know what he actually does want.

The Admiralty, it is well known, is of the opinion that the reconnaissance aircraft which fly over the seas and do purely naval work ought to be under its control. It cannot be said that such a view is illogical or unreasonable. If we had a clean slate and were now starting all our defence arrangements, surely we should lay down dividing lines between the work of the R.A.F., the air side of the Navy, and the air side of the Army; and in that case naval reconnaissance by air would certainly be put down as an Admiralty responsibility.

But the case of the Coastal Command is not on all fours with that of the Fleet Air Arm. There is no question of "operational control"—that breeder of dissensions. The Coastal Command works for the Navy and in close touch with the Navy. The liaison is, we understand, as close as can be, and the Coastal Command has the interests of the Navy and Merchant Navy as its only real *raison d'être*. There has been no suggestion from any quarter that the Coastal Command has not done its work well, or that that work could have been done better if the Command had been part of the Navy. Therefore, there seems no crying grievance, and consequently no reason for making a sudden great change in the middle of a critical war.



SINGLE OR TWIN? In his article on pp. 491-493 Mr. Sydney Camm examines their relative efficiencies. Here is a German twin, the Focke-Wulf 187.

WAR in the AIR

New German Methods : V.C. Fighter's Story : Heroism in Albania

BRING YOUR OWN AIRCRAFT : French airmen with the R.A.F. in the Western Desert fly their own machines. This pilot has a Potez 63 with two small diameter Gnome Rhone 14M engines of 680 h.p. each at 13,200 ft.

THE Germans seem to be converts to the idea of night bombing. They started the war with the theory that only day bombing could give enough accuracy to result in a military decision. So they tried day bombing and used every wile they could imagine to make it effective. The Fighter Command of the R.A.F. proved the futility of them all. Then came a period of what we British called "nuisance bombing," and after a while the Germans themselves adopted the name. Meanwhile they had been finding out by degrees that night bombing was a comparatively safe occupation. They lost some bombers, but not enough to discourage either the High Command or the air crews themselves. So, it seems, they decided to develop that form of attack.

But the Germans must have come to the conclusion that nothing very decisive could be accomplished by night bombing over such a huge area as London. We do not know how much information they receive as to the actual results of their efforts, but it must have been brought home to them that they could not make sure of damaging really important military objectives, and likewise that the slaughter of civilians and the destruction of venerated buildings, hospitals and such-like, was not going to deter the British from prosecuting the war with the utmost determination. Some other plan had to be tried. So, leaving London comparatively quiet for a while at least, they concentrated on important provincial cities which were smaller in extent, and which they believed contained a high proportion of munition factories. They doubtless argued that Britain could not possess an unlimited number of A.A. guns and teams, and therefore that it might be possible to surprise some place while the most formidable defences were congregated elsewhere.

Provincial Cities Bombed

THE raid on Coventry was the beginning of the new plan of campaign. Since then there have been heavy raids on Liverpool, Birmingham, Bristol, and Southampton, some of them delivered on more than one night. The loss of civilian life in these places has been tragic, and the destruction of private homes and of public buildings, such as Coventry Cathedral, is lamentable, but such things do not bring Germany one jot nearer winning the war. Such damage as has been done to munition factories is insignificant compared with the havoc which the R.A.F. bombers have been wreaking on German factories. As for *morale*, the people are British in all parts of this island, and Southerners, Midlanders, Westerners, and Northerners are all alike in refusing to be intimidated by the horrors which their cities have suffered. Great Britain is not to be defeated that way.

The German attacks show a regular procedure—flares, fire bombs, then H.E. But even the flares and the fires do not by any means always guide them to placing the H.E. bombs on military targets. It is civilians and the things which go with civilisation which chiefly suffer. No wonder Air Marshal Sir Philip Joubert de la Ferté said in an address to the Royal Empire Society the other day that he hated this present use of the aeroplane, and charged the Nazi régime with having turned it to war purposes at a time when Europe was turning to the development of commercial flying.

Some comfort is to be drawn from a consideration of the Germans' losses of aircraft in their foul endeavours. During November they lost 201 machines over Britain and British waters, and the Italians lost 20 more in the same area. Of these, 97 Germans and 7 Italians were bombers, 103 Germans and 13 Italians were either fighters or fighter-bombers, and one was a flying boat. During the same month 8 German aircraft were destroyed over Germany or territory occupied by the Germans, making a total of 229. In the Mediterranean and Northern Africa during November the Italians lost 59 machines. These figures include all aircraft destroyed by the R.A.F. or ground defences in the Northern area, but do not include enemy machines shot down by H.M. ships, armed vessels at sea, or the Fleet Air Arm. In the Mediterranean and African area the figures do not include the enemy machines destroyed by the Greeks or the armies in the field, or, again, by naval and marine agency.

The British losses during the month were 53 fighter machines and 25 pilots, and 48 bombers and reconnaissance machines in the northern area and 18 machines on the Italian front.

Since the war began over 3,000 German and Italian machines have been shot down by British fighters, A.A. guns, small arms and fire from trawlers, over or near Great Britain.

The First Fighter V.C.

MANY stories have been published which have given readers an idea of how our fighter pilots have achieved this wonderful result, but this broadcast recently delivered by Flight Lieut. J. B. Nicholson, V.C., the first man in the Fighter Command to win the Victoria Cross,

WAR IN THE AIR (CONTINUED)

TELL ME, ARE YOU HAPPY AT YOUR WORK? Feldmarschall Göring interviews some of his pilots on the subject of the R.A.F. Fighter Command.

will certainly be read with interest even by those who heard the broadcast. He said:—

"That day was a glorious day. The sun was shining from a cloudless sky and there was hardly a breath of wind anywhere. Our squadron was going towards Southampton on patrol at 15,000 feet when I saw three Junkers 88 bombers about four miles away flying across our bows. I reported this to our Squadron Leader and he replied: 'Go after them with your section.' So I led my section of aircraft round towards the bombers. We chased hard after them, but when we were about a mile behind we saw the 88s fly straight into a squadron of Spitfires. I used to fly a Spitfire myself and I guessed it was curtains for the three Junkers. I was right and they were all shot down in quick time, with no pickings for us. I must confess I was very disappointed, for I had never fired at a Hun in my life and was longing to have a crack at them.

"So we swung round again and started to climb up to 18,000 feet over Southampton, to rejoin our squadron. I was still a long way from the squadron when suddenly, very close in rapid succession, I heard four big bangs. They were the loudest noises I had ever heard, and they had been made by four cannon shells from a Messerschmitt 110 hitting my machine. The first shell tore through the hood over my cockpit and sent splinters into my left eye. One splinter, I discovered later, nearly severed my eyelid. I couldn't see through that eye for blood. The second cannon shell struck my spare petrol tank and set it on fire. The third shell crashed into the cockpit and tore off my right trouser leg. The fourth shell struck the back of my left shoe. It shattered the heel of the shoe and made quite a mess of my left foot. But I didn't know anything about that either, until later. Anyway, the effect of these four shells was to make me dive away to the right to avoid further shells. Then I started cursing myself for my carelessness. What a fool I had been, I thought, what a fool!

Down Goes the Me 110

"I WAS just thinking of jumping out when suddenly a Messerschmitt 110 whizzed under me and got right in my gun sights. Fortunately, no damage had been done to my windscreen or sights and when I was chasing the Junkers I had switched everything on. So everything was set for a fight. I pressed the gun button, for the Messerschmitt was in nice range. I plugged him first time and I could see my tracer bullets entering the German machine. He was going like mad, twisting and turning as he tried to get away from my fire. So I pushed the throttle wide open. Both of us must have been doing about 400 m.p.h. as we went down together in a dive. First he turned left, then right, then left and right again. He did three turns to the right and finally a fourth turn to the left. I remember shouting out loud at him when I first saw him, 'I'll teach you some manners, you Hun!' I shouted other things as well. I knew I was getting him nearly all the time I was firing.

"By this time it was pretty hot inside my machine from the burst petrol tank. I couldn't see much flame, but I reckon it was there all right. I remember looking once at my left hand which was keeping the throttle open. It seemed to be in the fire itself and I could see the skin peeling off it. Yet I had little pain. Unconsciously, too, I had drawn my feet up under my parachute on the seat, to escape the heat, I suppose.

"Well, I gave the Hun all I had, and the last I saw of him was when he was going down, with his right wing lower than the left wing. I gave him a parting burst and, as he had disappeared, started thinking about saving myself. I decided it was about time I left the aircraft and baled out, so I immediately jumped up from my seat. But first of all I hit my head against the framework of the hood, which was all that there was left. I cursed myself for a fool, pulled the hood back (wasn't I relieved when it slid back beautifully) and jumped up again. Once again I bounced back into my seat, for I had forgotten to undo the straps holding me in. One of them snapped and so I only had one to undo. Then I left the machine.

"I suppose I was about 12,000 to 15,000 feet when I baled out. Immediately I started somersaulting downwards and after a few turns like that I found myself diving head first for the ground. After a second or two of this I decided to pull the rip cord. The result was that I immediately straightened up and began to float down. Then an aircraft —a Messerschmitt, I think—came tearing past me. I decided to pretend I was dead, and hung limply by the parachute straps. The Messerschmitt came back once, and

FOURPENCE! An intimate study of an Italian bomb aimer missing the Ark Royal. The cash register keys belong to the bomb release gear.

WAR IN THE AIR (CONTINUED)

I kept my eyes closed, but I didn't get the bullets I was half expecting. I don't know if he fired at me; the main thing is that I wasn't hit. While I was coming down like that I had a look at myself. I could see the bones of my left hand showing through the knuckles. Then for the first time I discovered I'd been wounded in the foot. Blood was oozing out of the lace-holes of my left boot. My right hand was pretty badly burned, too. So I hung down a bit longer and then decided to try my limbs, just to see if they would work—thank goodness they did! I still had my oxygen mask over my face, but my hands were in too bad a state to take it off. I tried to but I couldn't manage it. I found, too, that I had lost one trouser leg and the other was badly torn and my tunic was just like a lot of torn rags, so I wasn't looking very smart. Then, after a bit more of this dangling-down business, I began to ache all over, and my hands and legs began to hurt a lot.

"When I got lower I saw I was in danger of coming down in the sea. I knew I didn't stand an earthly if I did, because I wouldn't have been able to swim a stroke with my hands like that. So I wriggled about a bit and managed to float inland. Then I saw a high-tension cable below me and thought it would finish me if I hit that. So I wriggled a bit more and aimed at a nice open field. When I was about 100 feet from the ground I saw a cyclist and heard him ring his bell. I was surprised to hear the bicycle bell and realised that I had been coming down in absolute silence. I bellowed at the cyclist, but I don't suppose he heard me. Finally, I touched down in the field and fell over. Fortunately it was a still day. My parachute just floated down and stayed down without dragging me along, as they sometimes do.

"I had a piece of good news almost immediately. One of the people who came along and who had watched the combat said they had seen the Messerschmitt 110 dive straight into the sea; so it hadn't been such a bad day after all."

In the last issue of *Flight* the story was told of how a flare was ignited inside a Whitley bomber and of how the plucky crew put out the fire and came home. It is gratifying to learn from the *London Gazette* that the imperturbable pilot, P/O. G. L. Cheshire, has been made a Companion of the Distinguished Service Order, and the very gallant wireless operator, Sergt. H. Davidson, has been awarded the Distinguished Flying Medal. Both of them belong to No. 102 Squadron.

The R.A.F. in Greece

THE amazing Greek Army continues to press on, and the Italians are still falling back before them in Albania. A spokesman of the War Office in London has uttered a warning that as the Greeks emerge from the mountains on to the plain, the Italian mechanised troops will have greater scope, and then the Greeks will be at a disadvantage. Despite the battering which the R.A.F. has given to the Italian ports on both sides of the Straits of Otranto, the Italians have contrived to get reinforcements across to Albania, and are said to be establishing a new line of defence. However, one report says that a number of picked Italian troops have been despatched by air in the hope of stemming the Greek onrush. That seems to suggest that the R.A.F. have made the ports at least inconvenient for use; but as tanks and heavy guns cannot be sent by air, the amount of help which these troops can give must be limited.

It is stated from Athens that Air Commodore J. H. D'Albiac, who commands the British forces in Greece, has been promoted to Air Vice-Marshal.

A very outstanding example of how accurate bombing can affect the course of a battle occurred during the Greek advance on Koritza, and it was also an example of the self-sacrificing devotion of R.A.F. men when great issues hang on their determination and thrust.

When the Italians were fighting back hard and rushing troops into the line in a desperate effort to hold the key town of Koritza, the Greek General Staff asked for special assistance by the R.A.F. If the Italian reinforcements could be prevented from getting into the line the scales would be turned against them.

That afternoon three Blenheim bombers, led by the Acting Commanding Officer of the squadron, set off to bomb important communications on the Pogradets-Koritza road. The weather was extremely bad and high-level bombing was impossible, but the Flight Commander and his two pilots dived down. Only one came back.

DOME OF DEFENCE: The front gunner of a Whitley with his Vickers K gas-operated gun. A spare drum of 60 rounds is mounted on the framework on the right of the turret.

BEST CELLARERS: Some of the crews who took part in the recent raid on Munich, during which, unfortunately, a bomb—larger than usual—overshot its target and landed in close contiguity to a certain beer-house.

WAR IN THE AIR (CONTINUED)

The reader is often amazed by the list of places attacked in the nightly raids by the Bomber and Coastal Commands. They are usually numerous and frequently widespread. There is not the least doubt that the targets hit are well chosen, for it is the Ministry of Economic Warfare which gives the Bomber Command the information on which it acts, placing the targets in order of importance for the bombers. The effect of these widespread raids is certainly great, and not the least part of their effect is the realisation which they bring to many millions of Germans (and to the overrun peoples who hate their oppressors) that the arm of the R.A.F. is long, and that no spot west of Berlin is immune.

Too Much Dispersion?

AT the same time, the onlooker is sometimes inclined to wonder whether there is not too much dispersion in the British bombing effort. Would it not be good policy to select some large target, say, the huge Krupp works at Essen, and concentrate practically the whole of our bomber strength on it continuously until it had been utterly destroyed?

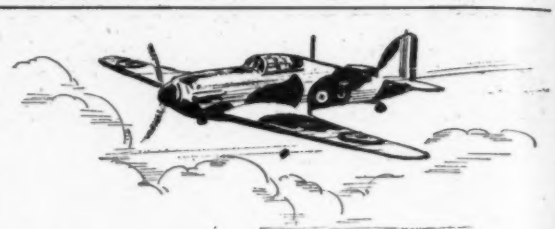
Of course, there are some classes of target which it is more profitable to bomb at intervals, waiting until a certain amount of repair work has been done, and then undoing it. It is also certain that too much concentration might give a free run to other places, such as oil refineries, to get on with their job for a while. All these considerations have to be weighed, but one is sometimes inclined to wonder whether the lure of a long list of targets visited during a single night is not proving unduly attractive.

All the same, there is no doubt that the heavy British attack during recent months has had its effect, and there is evidence that the German people are much impressed by the accuracy of the bomb-aiming. A neutral who had seen the results of the raid on the petrol tanks near Bordeaux remarked: "Your pilots are to be congratulated." The following remarks on the results of the British attacks have been published by the Air Ministry and Ministry of Information News Service:—

"Railways and oil plants are two of the weakest units in Germany's whole military and industrial organisation; satisfactory information about their gradual but persistent deterioration continues to come in. Here, our attacks on Berlin have been particularly useful, for Berlin is not being attacked merely because it is the capital of Germany but because it is, among other things, a very important railway centre. Several of its great terminal stations have been hit and some severely damaged, goods traffic has been held up for days at a time, and fires beside one of the largest stations caused great confusion. Damage done to this and other railway centres has the most far-reaching effect; it is reported that, as a result of interrupted communications, more than half of the coal mined in the Ruhr has to stay there and in consequence French factories, which the Germans wish to use for the manufacture of war material have to lie idle.

Good Targets

"THE synthetic oil plants of Germany are in themselves evidence of her unstable autarchy; they would never have been built if she had not intended war and sought by such costly expedients to make good her lack of oil. They are very suitable targets for our bombers; and much of the plant is necessarily flimsy. It is satisfactory that the reports of our pilots should be confirmed by news of hits upon Leuna, where one of Germany's largest synthetic oil plants is situated. Germany's oil reserves have been destroyed in many other parts of the country. At Stettin, cisterns of aviation petrol blazed for three days; so obvious a catastrophe compelled the Germans to admit in their official communique that two of the cisterns were destroyed, but actually it is now known that many were burned. At Hamburg, as a result of the raids of November 15 and 16, oil refineries caught fire and this was considered



one of the largest fires the city has yet seen. A kerosene depot was also set alight there.

"There are many reports of more miscellaneous damage. At Hamburg, during the same raids of November 15 and 16, several factories were destroyed, dumps of war material were hit, and an important railway station damaged. At Bremen, which has not been so heavily raided as Hamburg, the morale of the public is deteriorating; ships have been sunk in the harbour, and damage done to many dockside buildings and railways. In Berlin many factories have been damaged. At Frankfurt a chemical works which was hit two months ago had not been fully repaired a month later. At Dusseldorf a grain elevator was burnt out. At Mannheim a firm manufacturing petrol motors are finding it impossible to deliver the goods ordered from them, and in the same town a locomotive shed with eight engines in it received a direct hit."

Torpedoes and Mines

THE Coastal Command shares in the aggressive campaign, and there have been quite a number of instances lately of the Beauforts using their torpedoes to sink German supply ships. On one recent occasion the torpedo hit a tanker, which immediately went up in flames.

Another form of attack is the laying of mines in waters where German shipping is likely to ply. This is a task for the Bomber Command, for mines are not light, and need substantial aircraft to carry them in numbers.

On their nightly flights minelaying aircraft of the Bomber Command have now flown a million miles. They have cruised over Home Waters and penetrated through distant seas into channels where our mine-laying ships cannot go. They have dropped their mines in the North Sea, the English Channel, the Atlantic Ocean, the Kattegat, the Skaggerak and even the Kiel Canal. For the most part it is routine work free from enemy opposition, though sometimes an anti-aircraft battery from ship or shore attempts to bar the way. It is true that the minelayers carry bombs as well and to the crews themselves the adventure of the night only comes when they have put their mines in the right place and can search for enemy shipping in bays or inlets of the coast.

Effective Work

UNLIKE the men who fly over Berlin or over the Alps to Italy, the minelayers can bring back no thrilling reports of instant destruction. It is only very slowly, sometimes months after they have done their work, that they can know how much they have done to harass and disarm the enemy. In September, for example, the mines may have been laid, but only in November was it discovered that seven enemy ships, each of them severely damaged by mines, were lying at one end of the Kiel Canal. Or again, certain information may be pieced together until it is known that several ships were sunk in places where the Germans evidently did not know that mines were laid. The Germans themselves keep extremely quiet about these losses. Only the next of kin of casualties are informed, and they allow no details to be published. So great is the danger to German shipping from our mines that the German State Railways are refusing to accept goods for shipment by way of a number of Baltic ports and they decline to say how long this interruption of traffic will last. One of the Baltic routes is altogether closed. Convoys from Norway must now hug the coast.

(*Continued on page 493.*)

LOOKING AHEAD

Materials : The "Lobster-claw Dream" : Single- v. Twin-engined Installations : Submerged Engines

By SYDNEY CAMM

The Designer of the Hurricane

IN the survey which follows, many of the points made will not apply with equal force to both civil and military aircraft. It must be stated here that in the main the various conclusions have been derived from experience gained in the design of military aircraft.

Materials

I will commence with an examination of the materials position, as the choice of material is an important factor and determines much in both structural and general design.

Wood, while excellent for limited production and for certain classes of low-powered aircraft, cannot continue as the future material, because, apart from production difficulties, it entails in general a higher structural weight than can be obtained with the various classes of metal. A notable exception to this, of course, occurs in the case of airscrew blades.

In the design of comparatively small fighter aircraft, wood has a further disadvantage in that its large cross-sectional area reduces the amount of stowage space, the latter being already a limitation from other causes. This point is illustrated in the comparison of spar sizes given for a fighter of the Hurricane class. The use of various forms of compressed wood reduces this disadvantage considerably, although various practical limitations of this material must be borne in mind. At the moment, the presses in existence, although large, are capable only of producing comparatively short lengths. Special measures are necessary in design to combat the pronounced bad effect of bolt holes, etc., in this material.

The rapid and extensive development of light alloys is, of course, mainly responsible for the trend away from wood, as well as from high-tensile steel strip, although the latter in its various forms enabled us to produce structures of great merit for aircraft of the biplane class. Here we have a good illustration of the influence of general design on choice of materials. While the introduction of the cantilever monoplane did not compel the abandonment of fabric covering, it certainly invited the use of metal covering to meet the necessity for wing stiffness, and this was best accomplished in light alloy sheet.

Steel sheet has been considered as a covering, but to compare in weight with the 22 swg. light alloy sheet in common use, it is necessary to use steel about 0.010in. thick. This is so thin that the sheet is subject to extreme instability, and becomes uneconomical when account is taken of the very low permissible stress and the extensive stiffening involved. Fastenings are a problem also, bolts and rivets being quite unsatisfactory, leaving welding as the only solution. In such thin gauges the question of corrosion is serious unless stainless steel sheet is used.

Owing to the difficulty of attaching the sheet covering to main members of drawn strip, it became convenient, if not essential, to use light alloy sections in the form shown at B, the major advantage being that it then also became possible to concentrate the maximum amount of material at the maximum depth of the wing (*see p.* 492).

The two forms of Hurricane wing are a good example of this trend in design. The original design as fitted to early Hurricanes was a two-spar cantilever wing, braced torsionally with a Warren system of beams connecting the front and rear spars. Both the torsion beams and the spars were in H.T.S. rolled strip, the whole being fabric-covered on a rib framework. The later design of wing has spars with light-alloy booms, and is entirely covered with light-alloy sheet supported by pressed-sheet ribs. It is interesting to note that this wing is more than 10 per cent. lighter than the fabric-covered wing, and has nearly three times the torsional stiffness. Thus, while the demise of drawn steel strip for the main members is to be regretted, it was inevitable. Nevertheless, a good case can be made for reverting to steel of high tensile strength in rolled form, as shown at A, since, apart from the question of supply, it also allows more stowage space.

Much research has been applied to various forms of plastic materials, and great advances have been made. In spite of this, there are many points against their use, of which the following are a few: Thermo-plastics, as distinct from thermo-setting plastics, have very limited application such as for hoods and fairings. Special measures are necessary to meet the high coefficient of expansion, and the material is, of course, quite unsuitable in the engine bay, near the radiator, and even in tropical sun. Thermo-setting plastics generally have a low impact value, the presence of small holes for bolts, etc., aggravating this disability. Fabricated sheet, tube, etc., has its uses, but the fact that there is no satisfactory cement or glue limits the sphere of application. Moulded parts involve the use of expensive dies, and this in turn makes it impracticable to produce the part singly for the prototype aircraft.

There is, however, no doubt that for the immediate future this material will have great value in the construction of certain components such as seats, handwheels, pulleys, etc., and thus will tend to enforce a greater degree of detail standardisation.

Bearing in mind the various characteristics of the materials mentioned, it must be concluded that there will not be any comprehensive change-over to any one material in the immediate future.

Structure

In recent years we have seen the introduction of many systems of construction, each aiming at providing the specified load factors with the least weight. Of these, three main systems have survived: (a) the braced structure, with fabric covering carried on a light framework; (b) the so-called stressed-skin construction, in which there may, or may not, be a basic structure of spars, etc., but which has as its chief feature a sheet-metal covering reinforced by stringers, etc.; and (c) the geodetic system with a fabric covering.

For most military aircraft, and particularly those of the fighter class, it is rarely possible to use a pure system, the reason being that, owing to the limited stowage space in the fuselage of the modern fighter, it is necessary to make the utmost use of the wings. The large apertures

LOOKING AHEAD (CONTINUED)

needed for tanks, guns, undercarriage, etc., leave very little to which straightforward structural design can be applied. Of course, this position gets less difficult as the size of aircraft increases.

It does not appear that future development of wing structures will be towards the so-called lobster-claw type of wing, in which the interior is entirely devoid of structure. The need for the least possible structure weight, and for cut-aways for tanks, undercarriages, and so on, will enforce the retention of some form of internal structure with the lightest form of covering consistent with satisfactory torsional strength. There is much to recommend the use of high-tensile steel for the main heavily loaded members (the saving in fitting weight is not inconsiderable) with a covering skin of light alloy.

It seems likely that future development will not produce any new form of construction, but will extend along the line of more accurate determination of load-distribution, with improved detail design, and most modern aeroplanes have great scope for improvement in the latter direction.

General Design

The tendency will no doubt be towards the production of basic types in which the aircraft structure decides the foundation of the particular type, and also forms the basis of another type as the result of modifications to one or more of its components. This cannot, of course, apply to the two types which head their respective classes for offensive and defensive action, namely, the heavy long-range bomber and the high-speed single-seater fighter, since, if they are efficiently designed to fulfil their very specialised duties, they will not lend themselves readily to any major structural modification.

These two aircraft are at the opposite ends of the scale. There are intermediate types which are more adaptable to alternative duties. Take, for instance, the type designed primarily as a twin-engine medium bomber, with a crew of two; this can be converted to a multi-fixed gun and multi-movable gun day and night fighter. The single-engined dive-bomber, having fixed forward-firing guns and movable rear armament, is also adaptable to the requirements for a high-speed two-seater day and night fighter; the endurance as a night fighter can be considerably increased by carrying additional fuel in lieu of bomb load.

Not only can the single-engined and twin-engined types mentioned above be converted from bombers to fighters, but one or both of them can be converted to general purpose, Coastal Command or Fleet Air Arm Duties by minor modifications.

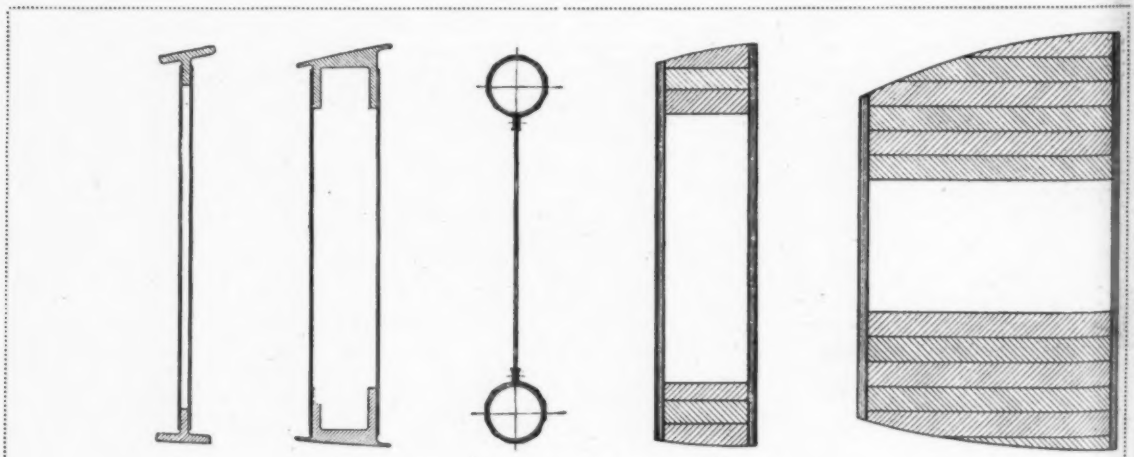
Improvement in Performance

The main development of the immediate future is one that is much overdue—the reduction of drag due to the engine nacelles of multi-engined aircraft, as in spite of the refinement in cowling of air-cooled engines and the ducted radiator of liquid-cooled units there still remains a large increase of drag over the average single-engined type, as shown by the following comparison in which the basic aircraft is a single seater with a 2,000 h.p. engine and a speed of 400 m.p.h. at 20,000 ft. with the drag analysis shown in column "A."

Drag in lb. at 100 ft./sec.

Unit	A	B	C
Body	17	13.5	13.5
Tail unit ..	8	8	8.5
Wing	35	35	37
Induced drag ..	6	6	6.5
Engine inst. ..	3	3	3
Nacelles ..	—	8	8
Interference, etc.	6	8	8.5
Total ..	75	81.5	85

If we now consider a twin-engined fighter with the



Hurricane centre-section spar alternatives.

LOOKING AHEAD (CONTINUED)

same power, similar in all external features except for the addition of two nacelles, and with a slightly smaller body, we obtain the figures shown in column "B."

This comparison gives the most favourable case for the twin-engined fighter, as in general it will be difficult to design a nacelle to give a drag figure as low as 4lb. Further, as the installation weight of the 2-1,000 h.p. units will be some 20 per cent. greater than that of the single 2,000 h.p. unit, the all-up weight and wing area will increase, and a more reasonable analysis will be that shown in column "C." Thus, the speed of the twin-engined aeroplane, assuming best possible nacelle design, will be approximately 16 m.p.h. less than that of the single-engined design.

An attack on this problem, of course, introduces the question of the future type of power plant, and there is no doubt that this inclines towards the liquid-cooled type. Evidence from existing types tends to prove the superiority of liquid-cooled installations from the low-drag point of view; and if internally-stowed engine plants are to be considered, this advantage seems to be extended.

Whether the engines will be internally stowed in the wing or fuselage is a question difficult to decide. The wing position is less attractive because the wings necessarily are kept as thin as possible, and also because the power unit would fill up a large portion of the space required for fuel load, etc. It seems, therefore, that a very good case can be made out, on fast fighter aircraft, for mounting the power plant (consisting of one or two units) in the centre fuselage, with geared shaft drives to either tractor or pusher airscrews. The installation weight will, of course, be seriously increased, but this is the price we must pay for increased speed.

The need for performance at much greater heights than at present will enforce a reduction in the high wing loadings, which are at present employed as a result of the desire for more speed. This will possibly mean that lower power loadings will also have to be adopted, making the use of multi-speed blowers essential to retain sufficient power at the higher altitudes.

In order to fulfil the exacting requirements for both take-off and high-altitude airscrew efficiency, multi-speed airscrew gearing, special thin-blade sections, multi-blade and contra-rotating airscrews all become increasingly important.

TRULY NEUTRAL: The "no man's land" which lies between Gibraltar and the mainland. In the background is the Spanish town of La Linea.

WAR IN THE AIR (CONTINUED FROM PAGE 490)

were destroyed were set on fire. Those damaged were hit by incendiaries or were machine-gunned.

When the Greek forces entered Santi Quaranta they found in the harbour an Italian destroyer badly damaged. Some few days previously the R.A.F. had reported that they believed they had made direct hits with two bombs on a destroyer. It is now proved that the vessel was so badly damaged that she had to make for Santi Quaranta, the nearest port.

It is now confirmed that in the air battle between a formation of R.A.F. fighter aircraft and large numbers of enemy fighters, CR 42s and G 50s, in South-western Albania on Wednesday, December 4, eight enemy aircraft were definitely shot down and destroyed, seven others severely damaged and seen to be in difficulties, and several more also damaged. All our pilots and aircraft returned to their bases.

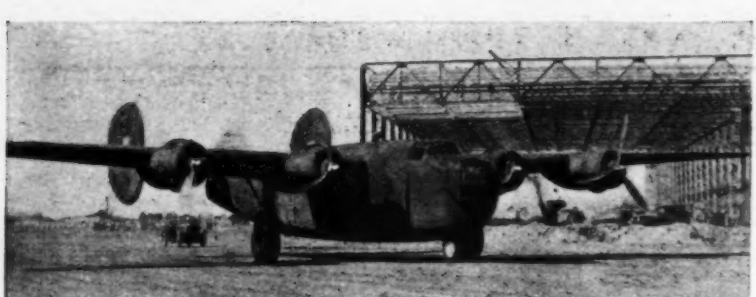
On the night of Saturday, December 7, a destructive raid by the R.A.F. was carried out on an Italian aerodrome at Kastel-Benito, near the town of Tripoli, in which at least eight Italian planes on the ground were destroyed and many more were damaged. The Italian aircraft which

AIR LOSSES DURING THE WEEK ENDING DECEMBER 7

	GERMAN Aircraft	BRITISH Fighter Aircraft	BRITISH Pilots
Dec. 1	8	5	—
" 2	2	1	—
" 3	—	—	—
" 4	1	—	—
" 5	14	2	1
" 6	—	—	—
" 7	2	—	—
	—	—	—
	27	8	1

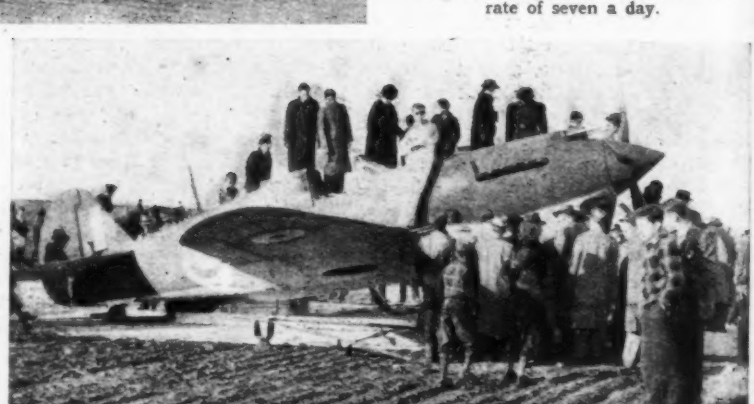
British Bombers lost over enemy territory:- Dec. 3, 3; Dec. 5, 2; Dec. 6, 2; Dec 7, 4. Total, 11.

HERE and THERE



A DIME A DEKKO: (Below) A Curtiss P.40 for the R.A.F. on show to the public in the U.S.A. These are alleged to be produced for us at the rate of seven a day.

TAILS UP: (Above) The first Consolidated B.24 bomber in R.A.F. warpaint to be flight tested at San Diego, California.



No Iron Crosses

THIS story of the bombing of a famous liner early in November off the Irish Coast is told by a radio officer. The four-engined Focke Wulf Condor came down to an altitude of only 200 feet after having dropped four bombs which went wide of the ship. Apparently the pilot decided that his fifth and last bomb should not miss. But when it struck it failed to explode and came to rest among the chairs and tables of the smoking room and only a few yards from some passengers. There was no panic, however. It was not considered wise to move the bomb; had it been dropped over the side of the ship it might have exploded on hitting the water.

When the pilot of the Condor realised his bombing plan had gone wrong, he swooped again, this time machine-gunning the decks. Even this failed to cause the havoc he planned. Then he dropped two or three small incendiary bombs, one of which started a small fire among some jute. This was quickly put out as the Nazi aeroplane headed for home. The liner resumed her voyage with the bomb aboard. It was finally disposed of when she reached port twenty-four hours later.

Delayed Parachute Jump

LOADED with scientific instruments, a Soviet parachutist, Polosukhin, recently made a delayed jump from an altitude of 8,050 metres (over 26,000 ft.). The aim of the jump was to determine the velocity of the human body falling freely through space. For this reason the descent was made from a balloon instead of an aeroplane so that there would be no horizontal velocity. Balloon USSR-79, having a volume of 2,500 cubic metres (88,000 cu. ft.) was used. This was designed for scientific observations. Polosukhin jumped from the gondola and delayed opening his parachute 10r 6,450 metres (over 21,000 ft.) During the fall the maximum speed registered was 102 metres per second. The temperature at the maximum altitude was −33 deg. C. When the parachute was opened the speed was reduced to 70 metres per second. The parachutist landed quite safely.

(The speed of free fall of 102 metres per second works out at 228 m.p.h., which is far above the value which has gained some sort of acceptance, though perhaps on flimsy evidence. This value is about 120 m.p.h., but *Flight* cannot vouch for its correctness. The speed with parachute open is given in the report as 70 metres per second; this is obviously wrong as it would be a he-man who could land safely at about 230 ft./sec. It probably should be 7.0, which is 23 ft./sec., a usual value.)

Consolidated 31 for Britain

THE Consolidated Model 31 flying boat, the first deliveries of which have been made available to Britain when they are ready, is another big American craft and will be very useful for long-range ocean patrol to counter the submarines. It is modernity itself, having two of the latest Wright engines, the Duplex Cyclone (two-rows, 18 cylinders, 2,000 h.p. for take-off), the Davis aerofoil (particulars of which have been given in *Flight*) and the latest structural development, pre-stretched stringers. To pre-stretch the stringers by cold-work raises the yield point and consequently the design stress. Production practice is to take Alclad material in the "SO" condition and to stretch it to give 3½ per cent. permanent set.

Greetings

A REPRODUCTION in colour of the *Flight* painting by our artist, F. Gordon-Crosby, entitled "In a World of Space," is again to be adopted by the R.A.F. Comforts Committee as their Christmas card, and the painting will also be available in the form of a calendar. Copies can be obtained from all high-class stationers, or direct from Raphael Tuck and Sons, Ltd., Raphael House, Moorfields, London, E.C.2. Prices are as follows:

Folder cards	3d. each.
Ribboned leaflet card ..	6d. each.
Calendars (11in. by 8½in. app.).	
Plain finish	1s. 6d. each.
Oil facsimile	2s. 6d. each.

Air Strategy—XXXI

ITALY AS A TARGET—III.

Why It Is Important : Some of the Difficulties Which Face the R.A.F.

By CAP AIN NORMAN MACMILLAN, M.C., A.F.C.

IT has been my good fortune to visit Italy a number of times and to fly over large parts of the country. I have crossed the Alps as a passenger with *Ala Littoria* when flying from Berlin to Venice and Rome. I have piloted myself along the Italian Riviera and down the west coast of Italy to Naples, and have looked down on the mountains where Bert Hinkler crashed. Brindisi I know; and the wide stretches of the Venetian Plain from south of the river Po up to the Dolomites. It is a strange mixture of the beautiful—alternately wild, peaceful, austere, picturesque.

Except under the worst of weather conditions (and they can be bad over Italy, with fog and snow in the north and storms and rain in the south) it is an extremely easy country over which to find one's way. And it is a country where it is impossible to fail to find one's chosen destination unless the weather is especially bad.

This question of weather is an important one for the Royal Air Force, especially in regard to raids over the industrial north of Italy. The plains of Piedmont and Lombardy lie in the shadow of the Alps. Often they are shrouded in a low-lying fog during the mid-winter months. This fog has sometimes a very low base, but is usually very shallow in height. It used to enshroud our aerodrome at Istrana so that we could see only a short distance on the ground. It can make landing a hazardous risk. In my recollection this low-lying fog was more prevalent by day than by night. Frequently as the warmth of the atmosphere ebbed with the oncoming night the fog lifted, leaving a starlit sky.

With a widespread anti-cyclone covering a large tract of Europe in mid-winter, I have found dense fog spreading from Berlin to the Alps in one unbroken field, the Alps themselves clear, and the North Italian Plain again covered by fog impenetrable to vision. It was not until the latitude of Rome was almost reached that the fog really changed into broken cloud. Under such conditions, target-finding in Northern Italy, in wartime, must be far from easy. Failing some form of first-class weather forecasting, it is essential to give British aircraft the opportunity to select alternative targets so that no flight made from the United Kingdom to Italy shall be wasted.

Great Work

The Royal Air Force flights right across France and over the Alps by night have not received the tribute they deserve in the Press generally. They are magnificent advertisements of British aircraft (and engine) reliability and maintenance, and they are brilliant examples of Royal Air Force navigation. Because it has been possible to overcome the flying difficulties attendant upon hazardous trans-Alpine raids, it is essential that not a single journey shall be robbed of its full value.

What is needed is a target selection list which is drawn up on the basis of depth of latitude. Alternative targets adjacent to one another in the fog shadow of the Alps may not give the aircraft crews the opportunity to see any of the objectives from their selected list clearly enough to obtain the accuracy of aim which is necessary to secure good results. If, however, the list is so drawn up that alternative targets are sought farther from the Alps, it is more likely that one of the targets will be readily identified and sighted.

A proposal of this nature immediately raises the question of range. Cases have been reported of Royal Air Force aircraft returning to their base aerodromes with their full load of bombs because the crews were unable to identify the prescribed target, or were unable to sight it with sufficient clarity to ensure accurate bombing. In a war of the kind upon which Britain and the British Empire are engaged such fruitless journeys are to be avoided at all costs. And there is no necessity for them when attacking Italy, for there are a sufficiency of targets available to aircraft possessing the requisite range of action.

By comparison with Germany, however, targets in Italy are not as concentrated; greater flexibility in radius of action is therefore required in aircraft attacking Italy than in aircraft attacking Germany. Even in the industrial north of Italy targets are scattered over a considerable area. Italy has no counterpart to the Ruhr and the Rhine.

"Out of Petrol"

The tale of one aircraft which got lost on the return flight after bombing a factory just south of Turin, and had to descend on the sea near a British naval vessel because its petrol was exhausted, shows how narrow is the margin between the safe return and the loss of an aircraft. Admittedly on this occasion the wireless on the aircraft had failed owing to electrical storms, and that made navigation a matter of Dead Reckoning or Celestial Navigation. Apparently Celestial Navigation was impossible owing to the depth of cloud, and some other land mass was mistaken for the Channel Islands; this threw out the Dead Reckoning pretty badly and the aircraft was still out of sight of land when it had to come down.

I know it is the fortune of war, and everyone rejoices when a gallant crew is saved; nevertheless that aircraft has to be replaced from the aircraft factories, which costs both time and money. It rather looks as though it ought to be worth while to equip our long-range bombers with a small auxiliary homing wireless set; several of these auxiliary homing sets were on the market for some time before the war began, and it ought not to be an insuperable difficulty to organise a system which would bring a British aircraft in to the United Kingdom safely in the circumstances just described, without giving anything away to enemy aircraft. A few aircraft saved would amply justify the production of such sets; their size and weight are of no importance whatever.

Turin and Milan are the two big Italian targets when the Italian aircraft industry is considered, and spread around these two cities, from Genoa in the west to Trieste in the east, there are many other targets which lie in the area I have defined as the northern target area of Italy. Apart from the two big cities and their environs, other targets in the area are isolated.

Thus, really by accident rather than by design, the Italian aircraft industry is partially protected from air attack by dispersion, and to undertake the complete

ITALY AS A TARGET (CONTINUED)

destruction of this enemy industry demands a very considerable degree of staff organisation, allied to good intelligence work and first-class flying.

Let us consider, for a moment, some of the targets which lie in the northern area I defined as the territory of Italy north of the line Genoa, Venice, Trieste, and including Italy's territory on the eastern side of the north of the Adriatic. In Turin the principal aircraft targets are the big Fiat works, where aircraft and aero engines are made as well as motor transport vehicles of all kinds. The Fiat works have been attacked several times.

In Turin there are also several other factories worth including within the range of counter-aviation targets. Among these are factories making airscrews, aircraft controls, retractable undercarriages, fuel gauges, fire-fighting apparatus, radio and telephone apparatus, airframe parts, and a factory of Dinamite Nobel, manufacturers of explosives.

Importance of Milan

Milan and its neighbourhood is even more important as a centre for the Italian aircraft industry. On the edge of the aerodrome of Taliedo on the outskirts of the city stands the main Caproni factory. Four years ago this big factory was employing something like five thousand hands, and was in process of enlargement. Its buildings are not arranged to withstand air bombardment, either in their structure or in their siting. It is one of the oldest aircraft factories in Italy, and like many of the old factories everyhere in the world it has expanded about its original nucleus. During the process of expansion due regard has obviously been paid to the value of land, and the spaces between the different buildings are narrow. Many of the buildings are of light construction and would not withstand the blast of heavy bombs. This factory has been one of the targets of the Royal Air Force, and it would be interesting to see photographs of the result in view of the apparent unsuitability of the factory to withstand heavy bombardment.

At Milan are also two large aero engine factories—Alfa-Romeo (makers of Bristol engines under licence) and Isotta-Fraschini (one of the largest aero-engine manufacturers in Italy). Their works, too, have had the unwelcome (no doubt) visits of the R.A.F.

Two more important aircraft factories lie in the neighbourhood of Milan. One is the Savoia-Marchetti factory at Sesto Calende, at the southern end of Lake Maggiore and some thirty miles north-north-west of Milan city. Three years ago the Savoia-Marchetti factory at Sesto Calende covered a surface of more than 50,000 square yards—ample size to enable the Royal Air Force to drop its bombs within the target area—as R.A.F. bombers have.

The situation of the factory in relation to the distinctively shaped lake, and near to the Milan-Simplon railway line, ought to make it a conspicuous target even at night, in spite of its close proximity to the Alps. The main units of the aircraft are built in this principal factory, and are then transported for assembly and flying tests to the Cameri aerodrome for landplanes and the Sant'Anna airport for flying boats. There are thus three actual targets connected with the output of the Savoia-Marchetti factory, for there are metal sheds and workshops on the aerodrome, and at the flying-boat station metal sheds, a factory and workshop, as well as a packing department for rail despatch.

Breda bombers and fighters are made in the neighbourhood of Milan, at Sesto San Giovanni. This is also an important aircraft factory, and a target of no small significance to attract the attention of the Royal Air Force.

Another large target which the R.A.F. have already attacked in Milan is the Magneti Marelli works. Other targets in Milan include aircraft instrument manufacturers, makers of duralumin, and engineering shops.

Important as are these two principal targets to Italian industry and the Italian war effort, it is obvious that they do not compare with the vast engineering and aircraft organisations of the Hitlerian Third Reich. Nevertheless, they are the basis of the life of the *Regia Aeronautica*, and as such their complete destruction would be a tremendous blow to Italian power in the air. It is certain that if Italian capacity to manufacture aircraft was written off by the Royal Air Force, it would become necessary for Germany to supply the nether end of the Axis with aircraft. Thus any damage to the Italian factories is damage to the total enemy war effort, and as such is bound to afford relief from the pressure of the German *Luftwaffe* in direct relation to the help that German industry must render unto Cæsar.

There are many other scattered air targets in Northern Italy, all of which deserve some attention from Royal Air Force raiders. Near Genoa, at Sestri-Ponente, is one of the Piaggio factories. There aero engines and airscrews are made. It has already received some attention, but probably not nearly enough. It is a valid war target, as war is waged to-day. There is another less important factory at Sestri which engages on the construction and repair of aircraft. This would be as well out of the way also.

Other Targets

The other aircraft targets in the northern area are widely scattered. At Trento there is the Caproni Cantiere works where aircraft are made. At Monte Colino, on Lake Iseo, Caproni seaplanes are made. At Bergamo is the factory of Caproni Bergamasca, engaged on aircraft construction. Near Varese, at Vizzola Ticino, is another Caproni works, and a Caproni flying school. All these factories form part of the big Caproni chain of aircraft factories, among which rationalisation has been carried to its greatest limits in the Italian aircraft industry. Moreover, Caproni was made a Count by Mussolini not so very long ago, and the two are said to be friends. If this is so, then hitting the Caproni ring is also hitting Mussolini in a more personal way than may be the case with other targets. That is a point worth remembering.

Another important aircraft factory in the northern area is the Cant. factory, whose products are in considerable use by the *Regia Aeronautica*. That factory, lying at Monfalcone-Trieste, is more distant than any I have yet mentioned. But its importance demands a special effort. It provides an instance of the tremendous importance to Britain's air war of the possession of aircraft of really long range and high speed. For range must be increased, but not at the expense of more hours of flight. As I have already recounted earlier in this article, one of our bombers returning from Italy came down in the sea after dawn. That was after an attack on Turin. It seems doubtful if it could have made the out-and-home journey to Trieste inside the hours of darkness at the speed at which it flew to Turin. Thus

ITALY AS A TARGET (CONTINUED)

it is important that range shall be increased by the increase of cruising speed rather than by any other means.

In a straight line Turin is 520 miles from the nearest point on the English coast. Trieste is just on 700 miles from the nearest point on our coast, an increase of 34 per cent. in striking range. We cannot lengthen the nights by 34 per cent.; very soon they will begin to get shorter instead of longer. And so it is becoming the most important factor in the British bombing programme, this dual effort to beat both time and distance with speed. Speed, and ever more speed, must be the demand of the bomber commanders. Speed at any price. For it is speed in the air on the wings of our bombers, as well as speed in the factories producing them, that will gain us the victory. Without speed in the air as well as speed on the ground the work of the workmen will be undone.

There are other targets in the north of Italy. The Macchi factory at Varese. In the same neighbourhood stands another of the Nobel Italian explosive factories. At Dalmine, near Bergamo, is a factory for the manufacture of steel and alloy tubes. At Condove war material is made for aircraft. At Gallarate there is a factory for aircraft construction. There is a factory for airframe construction and for the making of radio and telephone apparatus at Savigliano. Near Ivrea aluminium is made, and at Battaglia there is a factory engaged on precision work for aircraft.

Thus, in the northern area of Italy alone there is no real shortage of targets to enable a process of selection to be worked out. There need be no reason to return with undropped bombs, unless it is that more range is needed. And that, as I have said, means more speed. So let the aircraft industry take note that the main requirement in bomber aircraft is faster and faster cruising speed with no diminution in duration.

(Next Week: Central and Southern Italy.)

CORRESPONDENCE

The Editor does not hold himself responsible for the views expressed by correspondents. The names and addresses of the writers, not necessarily for publication, must in all cases accompany letters.

RUMM-RUMM BIRD

Same Noise Produced by Zeppelins

I READ with interest the article under the above title, and would like to recall to those investigating this problem that the Zeppelins of 1916-17 made the same noise. I have also heard it produced by a flotilla of heterogeneous motor boats of the R.N.P.S. recently. S. M. TOWNSEND.

Haslemere, Surrey.

SUB-CONTRACTING DRAWINGS

A Motor Manufacturer's Views

THE writer has followed with interest the letters in the Correspondence columns on "Design and Production," by "Sub-Contractor," and the subsequent letters from Mr. Gavin Starey and "H. W. E. C."

My firm are, in normal times, manufacturers of high-grade motor cars, and since the war we have turned over to a very large extent to the manufacture and assembly of an aircraft that is not yet in service, but was, we understand, specially designed to facilitate production by numerous sub-contractors, such as ourselves.

The more I come in contact with the Aircraft Industry the more I feel that they have not even begun to think of production as a motor car manufacturer conceives it.

The root of the trouble, I think, is that the initiating draughtsman is not encouraged or instructed to think intelligently from a production point of view when designing and detailing, and a typical instance of what I mean is concerned with the machine which my firm are making and assembling.

Like most aeroplane construction, this entails the drilling and reaming of tens of thousands of holes. When we came to tackle this part of the job we found that the drawings called for standard size holes, such as $\frac{1}{8}$in., $\frac{3}{16}$in. and $\frac{1}{4}$in., but added to the hole dimensions were the figures plus 0.002in. and plus 0.004in.

Now, our standard reamers would give the size plus 0.0005in., but as this did not produce a hole to drawing, thousands of special bastard size reamers had to be purchased, delivery from ordinary normal sources being quoted at something like twenty-seven weeks.

Upon my taking this up with the main contractors, they agreed that it would have been better if they could have started off the design with holes calling for the use of standard reamers, but by the time we came into the picture it was too late to do anything owing to the numbers of different firms building this job, and the interchangeability problem.

The point is that this particular job started off by being designed by an old-established aircraft firm of repute, and the manufacture of the various units was then undertaken by at least three other well-known aircraft manufacturers, but it was not until the ordinary motor car manufacturer, such as ourselves, came into the picture that anyone had queried such a simple and obvious point as this.

However, this is just one instance—of which there are hundreds—wherein the original draughtsman had not paid the slightest heed to production possibilities. It only requires a little attention in the early stages to make enormous savings in production times, without impairing the technical efficiency of the aircraft in any way.

I enclose my card, but sign myself "REAMER."

INVISIBLE VORTICES

Black and White

IN view of the learned interest which *Flight* and its readers have shown in the subject of sky trails, perhaps you will be interested in an example I observed a few evenings past. The air conditions were quite clear and cool, with thin mottled clouds covering a portion of the sky at, I should assess, about 20,000ft. A machine came out of the clear sky and, on entering the mottled area, left a narrow black lane behind it. Turning back across its previous track it proceeded out into the clear sky again, and, from the edge of the cloud, left the customary white trail. I should have mentioned that the clouds were lit from behind by a half-moon. Can *Flight* or its readers tell me whether the dark trails would be a dispersal of cloud in the path of the machine or whether what I saw was the shadow of a white trail laid at a slightly greater height than the cloud layer?

I enclose a sketch to show more distinctly how it appeared to me. A. J. PALMER.

BRITISH AIRCRAFT REVIEWED

Some 40 Types in Service, Representing 20 Designing Firms : The Difficulties of Standardisation

FOR a number of years it has been the practice of *Flight* to review the British aircraft industry towards the end of the year, and to try to assess the progress made during the previous twelve months. In present circumstances there are many reasons why a detailed review is neither possible nor advisable. For instance, Germany would like nothing better than to be presented, for the modest sum of ninepence, with a complete list of all the firms engaged in one way or another on the production of aircraft. Not only would she then be able to form a fairly close estimate of our output, but she would be able to judge to some extent whether or not Great Britain had mobilised her full production capacity.

As *Flight* has certainly no desire to assist the enemy in any way, we have refrained from giving in this week's issue the list of firms which in previous years we have published in this special issue. In the case of the old-established designing firms, however, there was obviously no point in refraining, since their existence and location are already well known to the enemy.

In the following pages the current types of twenty designing firms are described and illustrated. In spite of the urgent demand for quantity production, and the reduction of types which this demand has brought with it, it will be found that there are still nearly 40 different types of aircraft in use by, or in connection with the work of, the Royal Air Force. This is somewhat surprising, and might be used as an argument for still further reductions in the number of types. On closer examination, however, it is soon realised that scarcely a single one of the military types in the different classes could be dropped without incurring a loss in fighting efficiency.

The work of the Royal Air Force is very highly specialised, and although there are several cases on record of aircraft giving excellent service on duties for which the original designs were not planned, yet the fact remains that the future tendency is likely to be towards even greater specialisation rather than the reverse.

If the aircraft reviewed are grouped into classes, one can form a very good idea of the amount of "duplication" in each class.

It will then emerge that actually such duplication does not amount to very much. For instance, in the heavy bomber class (we still use the old-fashioned term from force of habit, although it is no longer an official classification) there are three types: the Whitley, the Hampden, and the Wellington. Superficially, it might appear that any one of these three would do all the work, and that a speeding-up of production would result from a concentration on one instead of three.

Not so Easy

That is the sort of argument which those not familiar with the intricate business of aircraft design and construction would use. In practice, the matter is not, unfortunately, as simple as that. In the first place, each of these three types has certain advantages and a few disadvantages, but neither can be said to incorporate all that is desirable. Between them they do, however, provide all that can reasonably be expected. There is another reason against the apparent simplification of having one type only. The designs and drawings of all three were in existence before the war; not only so, but jigs had been made and production started. To discontinue two of the types would mean that the manufacturers of them would have to remove existing jigs, workpeople would have to be trained in the production of the new type, and generally there would, at least for quite a long time, be a gap in production which could not be tolerated. We have used the bombers as an example; the same argument applies to other classes.

In the same way it might have been thought that specialisation on one or two types of engine would have been an advantage. Had that policy been followed we might never have had the Rolls-Royce Merlin, nor the Bristol sleeve-valve engines.

TYPES AT A GLANCE:

Single-seater Fighters	*Gladiator; Hurricane; Spitfire*
Two-seater Fighters	*Defiant*
Two-seater Fleet Fighters	*Fulmar; Roc*
Twin-engined Fighters	*Blenheim Fighter*
Twin-engined Bombers	*Whitley; Hampden; Wellington*
Twin-engined Multi-purpose	*Blenheim I and IV; Beaufort*
Dive-Bombers	*Skua; Henley; P.4/34*
General Reconnaissance	*Anson; Battle*
T.S.R.	*Swordfish; Albacore*
Army co-operation	*Lysander*
Ab-initio Trainers	*Tiger Moth*
Advanced Trainers	*Master*
Twin-engined Trainers	*Oxford*
Flying Boats	*London; Stranraer; Lerwick; Sunderland*

AIRSPEED

AIRSPEED (1934), LTD., is one of our younger firms. It was founded by Mr. N. S. Norway and Mr. Hessell Tiltman, and the first machine to be designed and built was the Courier, a low-wing monoplane with retractable undercarriage. Other types followed in quick succession, and the current type is the Airspeed Oxford, a twin-engined trainer designed to incorporate the main features of the modern military twin-engined machines.

The Oxford (two Cheetah X) is a trainer which incorporates most of the features of modern twin-engined military aircraft.

The Oxford is mainly of wood construction, and is powered by two Armstrong-Siddeley Cheetah X engines of 355 h.p. The machine is completely equipped for blind flying, and there is a manually operated turret for gunnery training. In the bomb well there is accommodation for 16 practice bombs.

There are fittings for wireless, navigational, photographic and oxygen equipment, and behind the gun turret is stowage for two parachute flares; so that it will be seen that there are few aspects of operational flying for which the Oxford does not provide training.

At a gross weight of 7,500 lb., the Oxford, with fixed-pitch airscrews, has a maximum speed of 192 m.p.h. at 8,000ft. Its normal cruising speed is 164 m.p.h. at 10,000ft.

Another interesting type, produced some time ago by the Airspeed firm, was the Queen Wasp. This is a biplane target machine controlled by wireless. For this class of work the machine is used as a floatplane, but a land undercarriage can be substituted.

ARMSTRONG-WHITWORTH

ONE of the companies in the Hawker-Siddeley group is Sir W. G. Armstrong Whitworth Aircraft, Ltd. The firm has a long line of successful military and commercial aeroplanes in its history, and was one of the first, if not the very first, to turn to all-metal construction. This was in the days of the Siddeley Siskin single-seater fighter biplane. Since then a great variety of types have been produced, varying from the smallest single-seaters to large commercial aeroplanes, a fact which bears testimony to the versatility of Mr. Lloyd, who is the firm's chief designer.

At the present time the type on which the firm is concentrating is the Whitley bomber. The Whitley Marks II and III were fitted with the Armstrong Siddeley Tiger engine, but the latest version has two Rolls-Royce Merlins, which give it a considerably better performance.

Somewhat unusual features are found in the design of the Whitley wing. The main structure is a box spar, in which the top and bottom surfaces are corrugated spanwise with very deep corrugations. To obtain the requisite wing form, a sheet covering is riveted to the outside of the corrugations. The front and rear walls of the spar box have vertical corrugations, and channel-section strips connect the vertical and horizontal surfaces of the box. The rest of the wing is of more orthodox construction, the trailing edge portion having tubular ribs with doped fabric covering. The fuselage is a stressed-skin monocoque structure, built in three sections.

Normally the Whitley carries a crew of five. Power-operated gun turrets are installed in the nose and stern of the fuselage, and there is a 'midships position in the form of a "dustbin" which can be rotated through 360 degrees. Bombs are carried in the centre section of the wing, and in the fuselage. The weight of bombs carried may not be stated, but the successes achieved by the Whitley in the war testify to the efficacy of the offensive load.

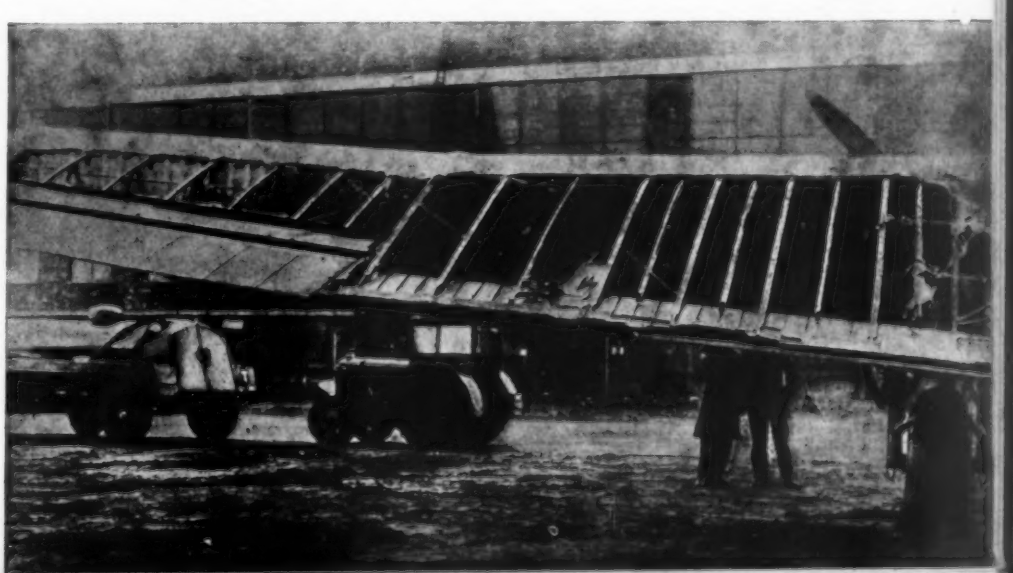
During the first months of the war the Whitley had little chance to do anything spectacular. It was, however, used extensively for dropping leaflets over Germany. The Whitley also took part in the historic raids on the German island of Sylt, one of the raids being led by Wing Commander Staton.

Here it might be recalled, by way of demonstrating the sturdy construction of the Whitley, that one of these machines was very badly damaged by anti-aircraft fire, the covering of nearly a whole wing being torn off. The damage is shown in one of our pictures. In spite of the loss of lift and control, the pilots, Gray and Long, brought it back safely to its base.

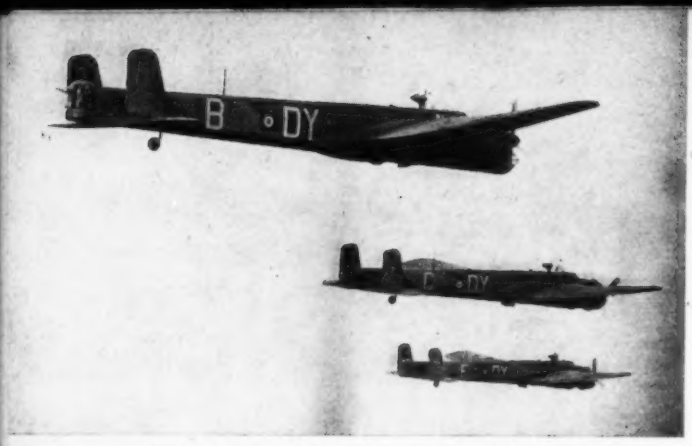
Whitley was also the type used when we first began to bomb Germany in May of this year, when Holland and Belgium were invaded by the enemy. More recently the type has been employed extensively for bombing military objectives in Italy, the range being sufficient to enable the machine to carry a very useful bomb load the necessary distance.

These are but some of the achievements which the Whitley has to its credit. One might mention many others, but it will suffice if we add that it has been used for leaflet raids as far afield as Poland, and also on so-called security patrols for German mine-laying. This work is now being done mainly by Hudsons, which would not be suitable for the long raids of which the Whitley is capable, nor, of course, could the Hudsons carry the bomb load of the Whitley.

To look at, the Whitley is not particularly prepossessing, but it does give an impression of effectiveness. And,



A battle-scarred veteran. A Whitley which, in spite of a stripped wing, returned safely to its base.



Whitleys in formation. The engines fitted are Rolls-Royce Merlins. Note the power-driven turret in the stern.

after all, "beauty is only skin deep," even stressed-skin deep. The type has served us well, and has by no means reached its limits of usefulness yet, although it is undeniably getting a little obsolescent.

On the other hand, a writer in an American journal has recently expressed the view that the fitting of Merlin engines has increased the speed by 50 m.p.h. and put the Whitley in the 300 m.p.h. class.

That Mr. Lloyd has spent the time well while the Whitley has been in production may be taken for granted and, incidentally, it is a mistake to think that a chief designer has nothing to do once his latest type is in full production. But it does give him a chance to look ahead to the next step. And in this case we may hope for a worthy successor of the Whitley.

AVRO

YET another firm in the Hawker-Siddeley group is A. V. Roe and Co., Ltd. This is one of the oldest aircraft companies in the country (and in the world), having been founded by that British pioneer, Sir Alliott Verdon-Roe, who is no longer interested financially in the company which he formed so long ago, but who still takes a keen personal interest in its products and in those members of the technical staff who were with him at the beginning, such as Mr. Roy Chadwick, the chief designer, and Mr. Dobson, works director. The inclusion of the firm in the large group has not affected its individuality, and its designs are to-day certainly as distinctively Avro as ever they were.

It has so happened that in the present war a single type has so far represented the Avro firm. On the other hand, that type has been built in very large quantities, and has survived to the present time, thus recalling the ever-young Avro 504, which for decades was the standard training machine of the R.A.F.

Curiously enough, this machine started life, so to speak, as a light commercial aeroplane. This was several years before the outbreak of war. At the time, the Air Ministry was wanting a new type for general reconnaissance work, and decided that a modified version would suit very well. Thus came into being the Anson. At the time it could scarcely have been foreseen that it was destined to become not only the reconnaissance machine it was originally intended to be, but a useful trainer, and when need be a fighter of unexpected merit.

The number of times the Anson has been mentioned is almost countless. Its main sphere of activity has been over the North Sea, where it has carried on a ceaseless vigil. Many are the useful reports which it has brought home, but it must not be supposed that it has confined itself to this purely passive performance, useful though it is. On more than one occasion it has met enemy aircraft, and instead of running away it has attacked and fought it out, often with superior numbers. For example, at the time of the Dunkirk affair three Ansons took on nine Messerschmitt Me 110s, shot down two and disabled two more. In view of the fact that it was hardly planned for this sort of scrap that was no small achievement.

For reconnaissance work the Anson carries a crew of three: pilot, navigator-bomb aimer, and wireless operator-gunner. All three are placed on the port side, the space on the starboard side being left free for their passage when changing positions.

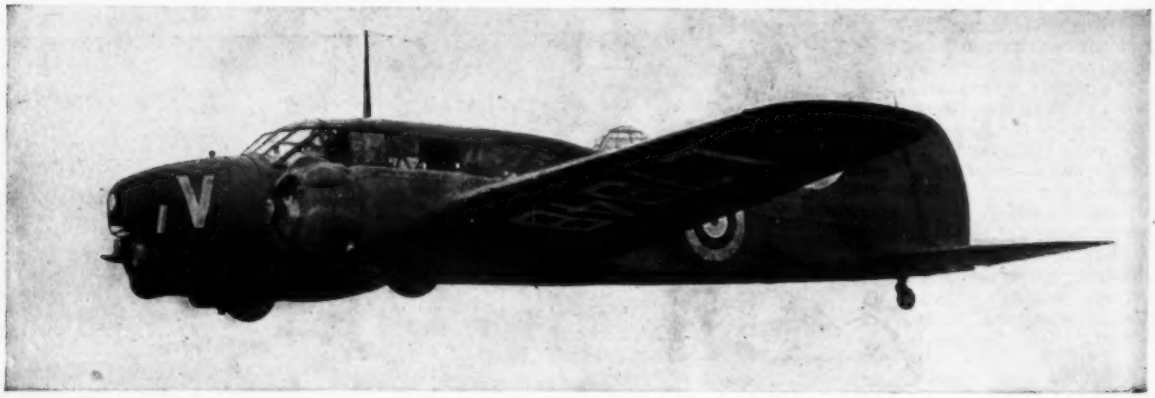
Armament

Defensive armament includes a fixed gun for the pilot and a movable gun carried in an Armstrong Whitworth manually-operated turret aft of the cabin. Offensive armament is in the form of a light bomb load carried in the centre portion of the wing.

The standard power plant of the Anson is two Armstrong Siddeley Cheetah IX engines of 350 h.p., driving Fairey fixed-pitch metal airscrews. At an all-up loaded weight of 8,000 lb. the Anson has a maximum speed of 180 m.p.h. at 7,000 ft. For reconnaissance over considerable distances the speed is, of course, reduced to something a good deal less.

From a structural point of view the Anson might be classed as old fashioned. There is, however, much to be said for a form of construction which makes for rapid production, especially when, as in the case of the Anson, it makes use of materials not in general demand for the more "refined" types. The fuselage is a welded steel tube structure with fabric covering; the wing has two main wooden spars of box section, the covering being a special bakelite plywood.

When the Anson was first produced the Avro firm made the claim that the welded steel tube fuselage would absorb more shock than any other type. This claim received somewhat unexpected confirmation some time ago, when two Ansons of the Royal Australian Air Force collided during a flight and became locked together. The pilot of the upper machine remained at the controls, the rest of the crews baling out, and landed the two machines without injury to himself, and without adding very much to the damage.



The Anson (two Cheetah IX engines) has done excellent work in the Coastal Command, on reconnaissance and, occasionally, fighting. The machine is also in service with the Royal Australian Air Force.

BLACKBURN

A FIRM which has, since the earliest days, been closely associated with sea-going aircraft is Blackburn Aircraft, Ltd. Even in the war 1914-18, Blackburn machines did good work over the North Sea. The founder and managing director of the company, Mr. Robert Blackburn, designed, built and flew his own aeroplanes as early as 1910.

In the present war two types have brought fame to the ancient firm—the Skua and the Roc. Actually, the two machines are almost identical, the main structures being the same, but the armament differing in accordance with the different functions for which the two types are intended. It might be mentioned here that the Skua was the first monoplane to be adopted for use from British carriers. It has a Bristol Perseus XII sleeve-valve engine, which gives it a top speed of 225 m.p.h. and a service ceiling of 20,200ft. It is of stressed-skin construction, the fuselage having watertight bulkheads to give buoyancy in the event of a forced descent on the sea. The wing has two box spars, flanged sheet ribs, and Z-section stringers to stiffen the outer metal skin.

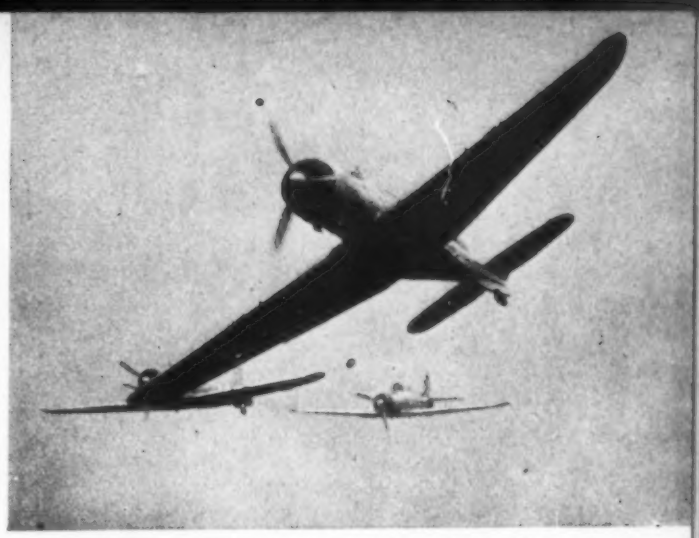
Having been designed for dive bombing, the Skua had to have means for limiting the diving speed. Flaps of unique form were designed, and it has been found that these prevent the machine from exceeding a speed of 220 knots during a dive.

Another feature peculiar to the Skua is the arrangement of the tail surfaces. In order to avoid blanketing of the fin and rudder by the tailplane, the vertical surfaces are set ahead of the horizontal.

The designers of the Skua faced many difficult problems. Not only did the machine have to be capable of being operated from carriers, which meant an arrester gear hook in the fuselage, but space is limited on carriers, and the wings had to fold. With a fixed undercarriage this would not have been difficult, but with a retracting undercarriage the complications were greatly increased. However, Mr. Petty, the chief designer, and his staff overcame all obstacles.

For some reason the Skua has not been given due official credit for the good work it has done in the war, and we suggest that, by way of encouraging the Blackburn workpeople, this defect should be remedied. There is probably no reason for the omission from the news of the Skua's achievements. It just so happens that they have not appealed to those whose business it is to select the news items.

By way of an example of the sort of task the Skua has tackled, we might mention that last spring sixteen of these machines flew from the Orkneys to Norway (Bergen) and there accounted for a German cruiser, with the loss of but one of their own number.



The Skua (Perseus XII) two-seater fleet fighter dive-bomber.

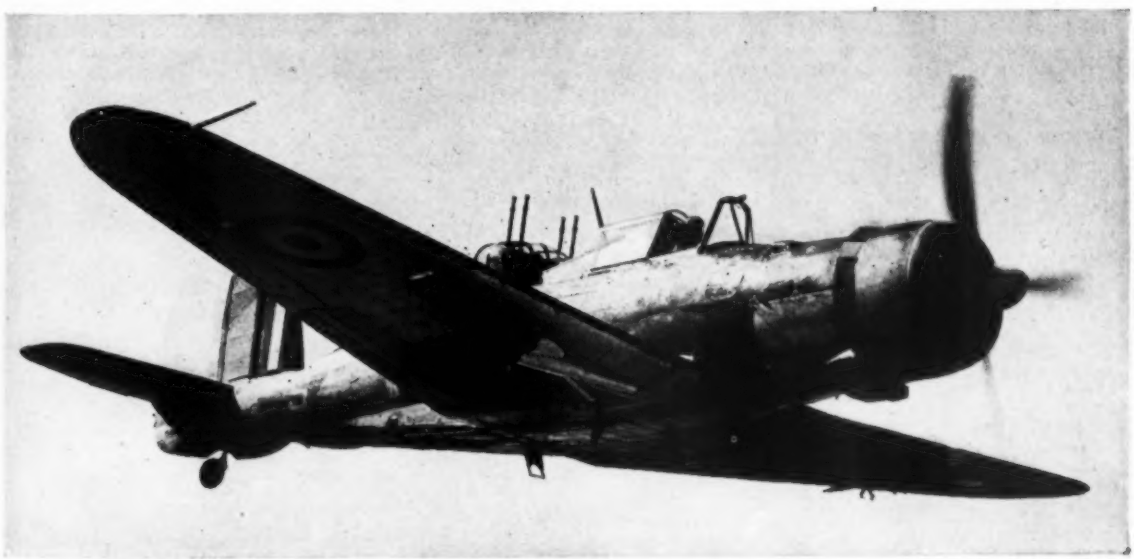
We have mentioned that the Skua and the Roc differ mainly in their armament. The Skua has fixed machine guns in the wings, and a single rear gun on a manually operated mounting. The Roc has no fixed guns, but has, on the other hand, its machine guns concentrated in a Boulton Paul power-driven rear turret. It might be added that the Roc has been built entirely by Boulton Paul.

BOULTON PAUL

ORIGINALLY started as the aircraft department of Boulton and Paul, Ltd., of Norwich, Boulton Paul Aircraft, Ltd., was formed as a separate company some years ago. The firm has, as mentioned above, built considerable numbers of the Blackburn Roc, but alongside this production has gone the manufacture of a machine of the firm's own design: the Defiant. This was originally intended as a night fighter, but during the earlier months of the war it was employed as a day fighter.

This use of the machine brought problems of its own, for the armament was arranged in one unit under the control of the gunner, there being no fixed forward-firing guns. Special tactics had to be evolved, and that these were successful is shown by the fact that the very first time the type was used as a day fighter (it was on May 12), three enemy aircraft were shot down off the Dutch coast.

The general design of the Defiant conforms to the ortho-



The Roc resembles the Skua, but has a Boulton Paul four-gun rear turret.

The Defiant is a two-seater night fighter with Merlin engine.

dox formula of low wing, retractable undercarriage, and stressed-skin construction. The lines of the machine are very attractive, and a distinctive note is lent by the straight triangular fin and the tapering rudder, the trailing edge of which slopes forward. If there is any difficulty in identifying the Defiant, this feature may always be relied upon to provide a clue. An inwardly-retracting undercarriage is used, and the struts and wheels have panels which close the openings in the lower wing surface. Split flaps run from fuselage to ailerons. The latter are of the Frise type.

Power for the Defiant is provided by a Rolls-Royce Merlin engine of recent type. It drives a three-bladed variable-pitch airscrew.

Performance figures of the Defiant may not be published, but those who have seen it fly are agreed that it is very fast.

BRISTOL

"SHIPSHAPE and Bristol Fashion" is an old saying, and it has come to apply to the products of the Bristol Aeroplane Co., Ltd., no less than to other things. Ever since the company was founded in 1910 by the late Sir George White, the Bristol firm has had a name for good workmanship.

"Blenheim" is the name given to the type which has upheld the Bristol tradition in the present war, just as did the Bristol Fighter (affectionately nicknamed the "Brisfit") in the last. The original Blenheim, or Mark I, had Bristol Mercury VIII engines, which gave it a top speed of 285 m.p.h. at 15,000ft. It was followed by the Mark IV, which will always be remembered as the "long-nosed" Blenheim. The original machine had a very short nose, which did not project ahead of the engines. The Mark IV, on the other hand, has a fairly long nose, mostly covered with transparent panels which afford the bomb-aimer an excellent view. The Mark IV has two Mercury XV engines, which develop 920 h.p. each for take-off.

With the extra power available for take-off, a larger fuel load can be carried, and the Mark IV has a range of 1,900 miles at a gross weight of 12,100 lb. The top speed is 295 m.p.h. at 15,000ft. A height of 20,000ft. is reached in the remarkably short time of 17 minutes.

Bristol Blenheims have been prominent in the news since the early days of the war. The type took part in the early raids on Kiel, was used by the Finns against Russia, made bombing raids on Norway, and has time after time bombed the invasion ports. Quite recently Blenheims have taken part in the Greek campaign.

Although originally designed as a bomber, the Blenheim's qualities as a fighter were too obvious to be overlooked, and the Fighter Blenheim has done very good work indeed.

Another Bristol type which has rendered excellent service is the Beaufort. This machine was first seen in public at the display given to Members of Parliament at Northolt. At that time the Beaufort was a very hush-hush machine, but behind the scenes it was known that it was a general-purpose type, intended for such different duties as bombing, reconnaissance, and torpedo-dropping.

In a general way the Beaufort may be said to resemble the Blenheim, but actually it differs a good deal from that machine in almost every particular. The most pronounced external difference is seen in the lines of the top of the fuselage, which come up to the level of the roof of the rear-gun turret. Internally the changes are even more pronounced.

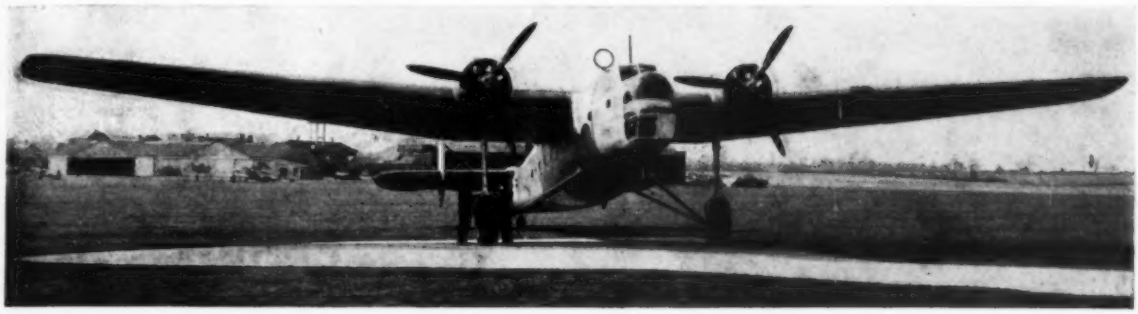
In place of the two Mercury engines of the Blenheim series, the Beaufort has two Taurus sleeve-valve engines. This, it will be remembered, is a slightly smaller engine than the Hercules, but still more powerful than the Mercury, so that it is obvious that the performance of the Beaufort is at least equal to that of the Blenheim.

The Beaufort was first mentioned in connection with raids on Waalhaven aerodrome in Holland after the German occupation, but actually it first took part during the Norwegian struggle. Recently it has been mentioned

The "long-nosed" Blenheim, or Blenheim Mark IV, has Mercury XV engines. It is faster and has longer range than the original Blenheim.

The Beaufort (two Taurus) on the right, is a general-purpose aeroplane which has done excellent work as a torpedoplane.

(Below) The Bombay (two Pegasus XXII) is a troop-carrier transport which has been built in large numbers by Short and Harland.



for its good work in torpedoing German ships off the Dutch and Belgian coasts. It carries an 18in. torpedo, As a bomber it carries a very impressive bomb load.

Among the types of aircraft produced by the Bristol company before the war was the Bombay. This is a troop-carrier, or as the class is called officially, a bomber transport—rather a curious and somewhat ambiguous title, introduced in the days before the war when it was not good form to refer to the war as war, but as a national emergency.

The Bombay has been produced, since the outbreak of war, by Short and Harland. It differs from other Bristol types in being a high-wing monoplane. It was designed for bombing, troop-carrying and for transporting engines and spares. It has defensive armament in the nose and stern gun turrets, and other guns firing through the sides of the fuselage. The engines are Bristol Pegasus XXII.

DE HAVILLAND

FOR very many years, in fact ever since the formation of the company, the products of the De Havilland Aircraft Co., Ltd., have been of a peaceful nature. The main connection of the firm with warlike flying has been the somewhat embryonic one of building trainers for the R.A.F. and for the Dominion Air Forces. The little Tiger Moth has been built by the hundreds, and is still being built, probably by the thousands. The machine is so well known that it needs no description in *Flight*, but it is worth recalling that in Canada the Tiger Moth is produced with a cabin top to protect pilot and pupil against the cold. It has also been "put on floats." The engine of the standard Tiger Moth is a Gipsy Major.

In the present war the famous name of De Havilland is represented by the Flamingo, originally designed as a commercial aeroplane. Not that the machine is used as a bomber, or anything quite as aggressive as that. But it still has its uses in military transport of one sort and another. Hence we see it frequently in full war paint, proceeding on its lawful occasions.

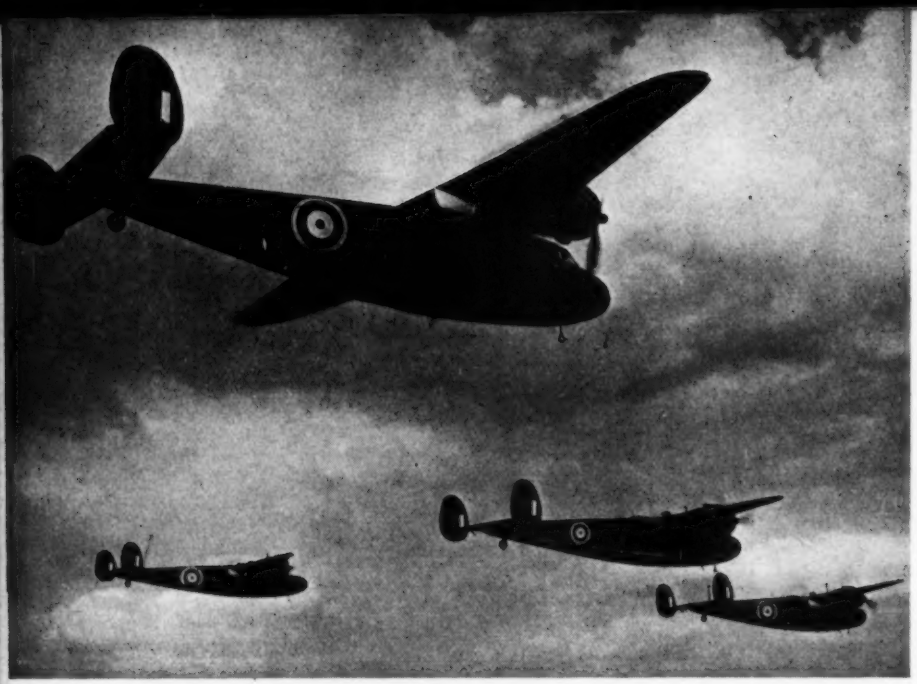
The 1940 version of the commercial Flamingo differs from the earlier model in having Bristol Perseus XVI sleeve-valve engines giving greater power at altitude than those of the original machine. Moreover, the De Havilland hydromatic airscrews have been fitted and, coupled with the extra power, this change has made possible an increase of 600 lb. in the loaded weight, which is 17,600 lb.

Fuel tanks for 402 gallons are provided, and these give a still-air range of 1,210 miles at 65 per cent. of continuous emergency power and 1,345 miles at 50 per cent. power. The maximum speed is 239 m.p.h. at 6,500ft., and the cruising speed about 200 m.p.h.

Apart from the Tiger Moth and Flamingo, other De Havilland types are still in use on peaceful errands. Notably is this so with the Rapide biplane, which is doing a lot of work of different sorts.

Shortly before the outbreak of war the De Havilland Aircraft Co., Ltd., introduced the Moth Minor, a small low-wing monoplane with Gipsy Minor engine. Extensive development work was carried out, and both open and

The Tiger Moth (Gipsy Major) is the standard *ab initio* trainer for the Royal Air Force.



The Flamingo (two Perseus) is used extensively for R.A.F. work, although originally designed as a commercial aeroplane.

cabin versions were produced. The machine was suitable for flying training and for private use, and arrangements were made to build the machine in Australia by the De Havilland company there.

FAIREY

THE Fairey Aviation Co., Ltd., was founded during the last war, but the aeronautical career of Mr. C. R. Fairey himself goes back much farther than that. In fact, he was associated with the Blair Atholl Syndicate which built the tailless aeroplanes designed by Col. Dunn.

We have not the space here to refer to the numerous interesting aircraft which the Fairey company has designed and built, but must confine ourselves to the current productions of the firm which have taken and are taking an active part in the war.

Oldest of these is the Swordfish, a biplane T.S.R. (torpedo, spotter, reconnaissance) type with Bristol Pegasus engine. It is available with wheel or float undercarriage. The machine carries a fixed gun firing through the airscrew, and one Lewis gun on a Fairey high-speed mounting. Offensive armament comprises one 18in. torpedo or the equivalent bomb load. The maximum speed is 154 m.p.h. The Swordfish type covered itself with glory in the recent Taranto action.

Next in seniority comes the Battle, a low-wing monoplane to the modern formula, incorporating stressed-skin construction. It is a two-seater medium bomber, fitted with the Rolls-Royce Merlin engine, which gives it a speed of 257 m.p.h. at 15,000ft. The Battle did good work in the early days of the war when squadrons were stationed in France, and F/O. Garland and Sgt. Gray were awarded the first two V.C.s of the war for their share in attacking the bridge over the Albert Canal at Maastricht. They were the crew of one of the five Battles which were sent out to destroy the bridge.

Brief mention should be made also of the little Sea Fox (Napier Rapier) seaplane which played an important part in the sinking of the *Graf Spee* by its reconnaissance. It was catapulted from the *Ajax* and was piloted by Lt. Lewin, R.N., whose observer was Cpl. Brooks, M.B.E. A D.S.O. was awarded the pilot.

The modern successor of the Swordfish is the Albacore with Bristol Taurus 14-cylinder sleeve-valve engine. Like the Swordfish the Albacore can be used for reconnaissance, spotting and torpedo dropping. It is also a dive bomber. The Albacore is of fairly recent date, and already it has done good work with the Fleet in the Middle East. Its large wing area enables it to carry a heavy military load.

The latest Fairey type to go into service with the Fleet is the Fulmar, the Navy's fastest two-seater fighter.

The Albacore (Taurus) can be used for dive-bombing, torpedo-dropping, fleet spotting and reconnaissance.

(Left) "Bombing-up" a Fairey Battle (Merlin).

Already it has several confirmed victories to its credit, and there is no doubt that it will give an excellent account of itself during the months to come.

Originally the Fulmar was designed to the specification P.4/34 and was a light bomber. It resembles the Battle in general lines, but is smaller and faster. In the original machine the bomb load was carried externally. At the Brussels show before the war it was exhibited as a multi-gun fighter, and had been ordered by Denmark. Thus some of the groundwork had been done. For use with the Fleet, however, it was necessary to arrange for the wings to fold, and this meant a fairly major modification. So much so that the Fulmar can scarcely now be said to be a P.4/34 conversion, but should rather be regarded as an entirely new design. The engine is a Rolls-Royce Merlin.

In addition to its high performance, the Fairey Fulmar

is of immense value to the Fleet Air Arm on account of its heavy armament, which includes eight guns in the wings.

Details of dimensions and performance of the Fulmar are not available, but it may be recollected that the original P. 4/34 had a wing span of 47ft. 4½in., a wing area of 346 sq. ft., and a gross weight of 8,800 lb. With a Rolls-Royce Merlin II the maximum speed was 284 m.p.h. at 17,000ft. The service ceiling was 29,600ft. It is probable that weights and loadings are different in the Fulmar, so that these figures cannot be assumed to apply, but they do give some indication of the qualities which the Navy's new two-seater fighter is likely to have.

(Right) **The Fairey Swordfish (Pegasus) did very effective work at Taranto recently.**

(Below) **The Fairey Fulmar (Merlin), the Navy's latest multi-gun fleet fighter.**

GENERAL AIRCRAFT

ONE of the newer British aircraft firms is General Aircraft, Ltd., the managing director of which is Mr. E. C. Gordon England, who was one of the earliest British aircraft designers, and a pilot as well. After the last war Mr. Gordon England deserted aviation and became famous as a builder of motor bodies, but his old love proved too strong, and several years ago he returned to aviation.

At the present time General Aircraft is, like all other aircraft firms, busily engaged on war work, but time has been found to design and build private aeroplanes as well. Some time before the outbreak of war the firm acquired the building rights in the Cygnet light plane, a small two-seater all-metal monoplane with tricycle undercarriage. For a time production had to be suspended owing to difficulties in getting materials, but gradually the obstacles were overcome, and some months ago a Cygnet was sent to Brazil on a demonstration tour.

That there is every likelihood of orders seems certain from the reception given to the machine, but equally important is the fact that the South Americans have been greatly impressed by the unexpected revelation that Great Britain can, in spite of her preoccupation, find time, energy and materials to export aircraft under present conditions.

The Cygnet is powered by a Cirrus Major engine, which gives it a top speed of 135 m.p.h.

Quite recently General Aircraft has introduced an open two-seater trainer, the Owlet. This is obviously useful for *ab initio* training, as it will reduce the time taken by a pupil to become ready for the solo stage. As the machine has a tricycle undercarriage, it will be extremely useful for training pilots in the tricycle technique which they will have to acquire before being passed out on the new American military types with tricycle undercarriage which Great Britain has ordered from America. The Owlet also has a Cirrus Major engine, and is equipped for night-flying and instrument-flying training. Would make pleasant open tourer.

The Cygnet (Cirrus Major) has recently been exported to Brazil, where it has created a very favourable impression.

(Right) **The Owlet (Cirrus Major) is an *ab initio* and night-flying trainer with tricycle undercarriage.**

Gladiator pilots ready by their machines. The Gladiator (Mercury VIII A) saw fighting in Finland, and has given good service in the Near East, not a bad achievement for an old-timer.

GLOSTER

AT the present time the Gloster Aircraft Co., Ltd. (a member of the Hawker Siddeley group) has only a single type of its own design in service. This is the Gladiator, of which two versions are in use, the standard Gladiator and the Sea Gladiator. The two do not differ greatly, except that the Sea Gladiator has the usual ship plane equipment, such as a rubber dinghy and a hook under the fuselage for the arrester gear on carriers.

The Mark II Gladiator has a Bristol Mercury VIII A engine and an armament of four Browning machine guns. The top speed is 255 m.p.h. at 15,000ft., and the service ceiling 32,800ft.

In the war the Gladiator has done well. It was the fighter used by the Finns, and was flown off the ice in the Norwegian campaign, when Gladiators shot down six enemy aircraft and damaged eight more. Sqn. Ldr. Donaldson, it may be remembered, was awarded a D.F.C. for this action.

The Gladiator is the descendant of a long series of biplane fighters, designed by Mr. H. P. Folland while he was chief designer to the company, and before he founded his own firm. The present designer is Mr. W. G. Carter, who was, curiously enough, chief designer to the Hawker company some years ago, before the Gloster Aircraft Co. became a member of the Hawker-Siddeley group. One may suppose that Mr. Carter has not been idle during the last few years, and, in fact, something which seemed to bear his stamp streaked past the spectators at the Parliamentary visit to Northolt before the war.

HANDLEY PAGE

MR. FREDERICK HANDLEY PAGE is one of the pioneers of British aviation, having designed aeroplanes since about 1910. In the last war his contribution was the O/400 twin-engined bomber and the V/1500, the latter being finished just too late to make the projected bombing attack on Berlin.

In this war the Handley Page name is represented by the Hampden, a twin-engined low-wing bomber with two Bristol Pegasus XVIII engines. The crew includes pilot, navigator-bomber, wireless operator-gunner, and lower rear gunner. The maximum speed of the Hampden is 265 m.p.h. at 15,500ft. The service ceiling is 22,700ft. The maximum range is 1,790 miles.

Space does not allow of a detailed reference to all the Hampden successes in the present war, but it was used against German vessels in the Norwegian campaign and a cruiser was bagged, for which F/O. French was awarded the D.F.C. For bombing the Dortmund-Ems canal aqueduct in a Hampden, Flt. Lt. Learoyd was awarded the V.C. He came down to 150ft. In the big raid on Sylt 49 Hampdens dropped 45 tons of bombs, and Sqn. Ldr. Turner and Flt. Lt. Bennett were awarded the D.F.C., while Sgt. Fletcher was awarded the D.F.M.

Some years ago an arrangement was made whereby the English Electric Co., Ltd., were to build Handley Page aeroplanes, and it is to be supposed that by now that firm is adding substantially to the output of the Handley Page factory.

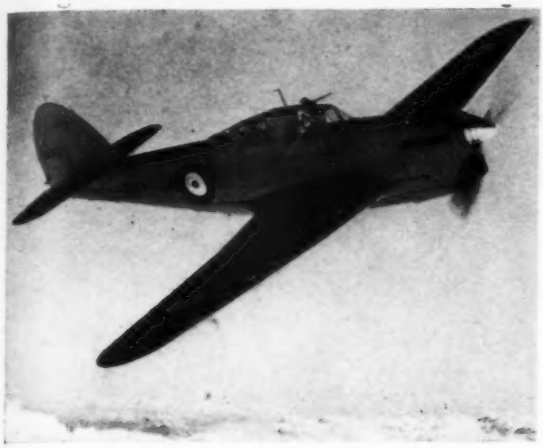
A modified version of the Handley Page Hampden is the Hereford. As will be seen from the picture on this page, it differs from the original machine mainly in that in place of the Bristol Pegasus engines it has two Napier-Halford Daggers. These 24-cylinder engines have been very neatly faired into the wing. The Hereford has been built by Short and Harland, of Belfast, who also built numbers of the Bristol Bombay.

The Hereford is similar to the Hampden below, but has Napier Dagger engines.

(Left) The Hampden (two Pegasus XVIII) has, among other targets, the Dortmund-Ems canal aqueduct to its credit. On the right is seen preparation for a raid.

(Right) The Hurricane (Merlin) has accounted for some 1,500 German aeroplanes.

Originally designed to the P.4/34 specification, the Henley (Merlin) shown below was converted for high-speed target-towing, a somewhat wasteful use of a very fine aeroplane



HAWKER

IF one takes into account the fact that Hawker Aircraft, Ltd., is a direct descendant, via the H. G. Hawker Engineering Co., Ltd., of the old Sopwith firm, Hawkers are among the oldest aircraft firms in the country. And those who guide its destinies have either been with the firm from the beginning, or at least since some time during the last war.

For very many years the Hawker firm has concentrated on small single-seater and two-seater military aircraft, and the Hurricane, which is the Hawker type that has won honour and glory in the present war, is thus a descendant of a long line of ancestors. A fact which is often overlooked is that actually Mr. Sydney Camm, the firm's chief designer, designed the Hurricane seven years ago. That it has been improved in detail during that period goes without saying, but fundamentally the design of the first machine was the same as that of the latest version. For example, improved Merlin engines have been installed, and variable-pitch airscrews have been substituted for the fixed-pitch wooden airscrew of the first machines.

There is probably not a man, woman or child in the country who has not heard of the Hurricane, as the machine has figured in the news since the earliest days of the war. The Hurricane was the single-seater fighter chosen for operations in France, its sturdy construction and wide undercarriage track making it suitable for use from aerodromes often soft with mud or covered in snow.

So far as can be ascertained, the first official reference to the Hurricane in France was on October 30, 1939, when one brought down a Dornier Do 17.

Again in the battles for the Low Countries and France, the Hurricane did terrific slaughter. At the present time more than 1,500 enemy aircraft have been brought down by Hurricanes, and the number is growing daily. It will also be recollected that the first V.C. to be awarded to a fighter pilot was that of Flt. Lt. J. B. Nicolson. So the Hurricane may be said to have done all that could be expected of any aircraft. In fact, it has done more; and its period of usefulness is far from being over. It is still capable of development and adaptation.

Structurally the Hurricane is interesting in that it adheres to the system introduced by the Hawker firm in the old biplane days, with a fabric-covered girder fuselage and, initially at any rate, fabric-covered wings. Later examples of the Hurricane have stressed-skin wings, but the fabric covering was actually quite satisfactory.

The armament of the Hurricane includes eight Browning guns in the wings, but alternative equipment can be installed. The engine of the Mark I Hurricane is a Rolls-Royce Merlin III of 1,030 h.p. This gives a speed of 335 m.p.h. at 18,500ft. The service ceiling is 35,000ft.

One Hawker type which has not received the appreciation it deserves is the Henley. Originally designed to specification P.4/34 as a light bomber, it went into small production as a high-speed target-towing machine, a job which seemed a waste of a very good aeroplane. Even now the machine is worth reviving for a different purpose, and as the drawings are all in existence, as well as many of the jigs, there need be no long delay in getting it into reproduction, if we may use the expression.

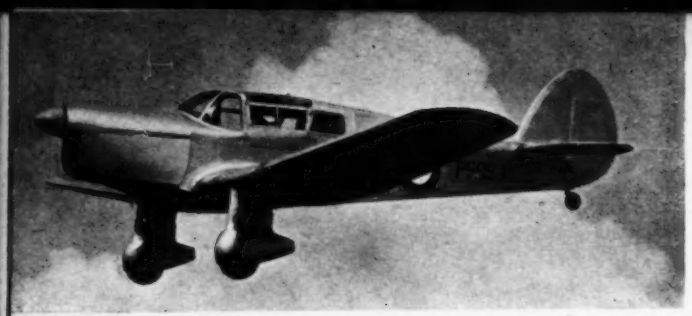
By way of showing how good an aeroplane has been wasted, we may point out that in its original form, and before the unsightly and drag-producing sleeve-towing arm was added, the Henley had, at a gross weight of 9,000 lb. and carrying a disposable load of 3,350 lb., a maximum speed of 300 m.p.h. at 17,500ft. It climbed to 19,680ft. in 15 minutes, and its service ceiling was 29,000ft. That was when the Henley was a dive-bomber," which is another way of saying that its structure was remarkably strong.

PARNALL

THE original Parnall aircraft firm was founded by the late Mr. George Parnall during the last war. It started as a section of his shop-furniture works at Bristol. Some years ago the firm was re-formed, under the title Parnall Aircraft, Ltd., with Capt. Frazer Nash and Capt. Grattan Thompson as its moving spirits.

Although largely occupied on war work, the firm has not abandoned its design side, under Mr. Basil B. Henderson, and one need not be surprised if he springs something on us one of these days. In the meantime the firm has had under development for more than a year a monoplane trainer, the type 382, with Gipsy Six engine. Mr. Henderson has long been a believer in Handley Page slots and slotted flaps, and the trainer is liberally provided with both. Controllability is thus of a high order, while the stalling speed is remarkably low at 43 m.p.h. This is with engine off. The top speed is in the neighbourhood of 155 m.p.h.

The Parnall 382 trainer (Gipsy Six) has Handley Page slots and slotted flaps.



The Percival Proctor (Gipsy Six) shown on the left is used for deck-landing and navigation training.

(Below) The Percival Q.6 (two Gipsy Six) was originally a light transport but is now used by the R.A.F.

PERCIVAL

CAPT. E. W. PERCIVAL came to this country several years ago, after extensive experience of air route flying in Australia. He produced a number of interesting light planes, of which we may recall the Gull, the Vega Gull, and the Mew Gull. He took part in nearly every race for the King's Cup, and was always well to the front.

Some months ago Capt. Percival resigned from his position as managing director in favour of Capt. P. D. Acland, but he is still a director of Percival Aircraft, Ltd.

Two Percival types have come into use during the war: the Proctor and the Q.6. The former is actually an adaptation of the Vega Gull to make it suitable for deck-landing and navigational training, and the latter is used for service communications work. Both types have Gipsy Six engines. The Q.6 was designed as a six-seven-seater light commercial machine, with a top speed of 195 m.p.h. The Proctor has a maximum speed, when fitted with the Gipsy Six, Series II, of 180 m.p.h.

PHILLIPS AND POWIS

SOME years ago the Rolls-Royce firm obtained a controlling interest in Phillips and Powis Aircraft, Ltd. At once a strong policy of trainer development was instituted, and the type on which the firm decided to concentrate was the Master, designed by Mr. F. G. Miles.

The Miles Master is an advanced trainer fitted with the Rolls-Royce Kestrel XXX engine. Its purpose is to serve as an intermediate step between the usual trainer types and the service machines which pilots have to fly in the R.A.F. Consequently the machine is fitted with "all modern conveniences," such as retractable undercarriage, trailing edge flaps, and variable-pitch airscrew. Thus on the Master the pupil can familiarise himself with all the controls he will have to handle in the powerful service machines. The Master is of wood construction, and the aerodynamic design is characterised by a wing of inverted gull's wing shape, and by a very tall and narrow fin and rudder.

As the Kestrel engine fitted is powerful for a trainer (550 h.p.) the Master has a high performance, which fact also helps to make it suitable for advanced training. The top speed is 264 m.p.h. at 15,000ft., and the machine cruises at 230 m.p.h. on two-thirds power. The climb to 15,000ft. takes ten minutes, and the service ceiling is 28,000ft., which is high enough to give pupils experience of flying at the heights at which they will operate when piloting single-seater fighters.

It seems probable that Phillips and Powis were the first British firm to introduce the moving line track assembly for aircraft. The Master is now being assembled in this way.

SARO

FOR almost as many years as yachtsmen can remember, S. E. Saunders, of Cowes, was a familiar and picturesque figure. During the last war he turned to aircraft production, in addition to his yacht and motor-boat building. After the last war, and a few unsuccessful ventures along very original lines, he put aviation on the shelf, so to speak, but was always interested, and when Sir Alliott Verdon-Roe disposed of his interests in the Avro firm, he turned to Sammy Saunders and his works. The two soon came to an agreement, and the firm of Saunders-Roe was formed. With the close association with boat building it was but natural that seaplanes should form the chief interest of the firm, and the first machine to leave the stocks was the little *Cutty Sark* flying boat, which was an interesting design but somewhat before its time.

For purposes of identification, the name Saunders-Roe was contracted into Saro, a prefix used in all the firm's products ever since. Mr. Saunders has since died, as has also Sir Alliott's old friend John Lord, who shared "A.V.'s" good and bad fortunes through all the years, but the name Saro has taken root, and from the time of the firm's formation the services have never been without a Saro flying boat of some sort.

For a good many years the Saro London was used by the Coastal Command as an open sea reconnaissance flying boat. It had two Bristol Pegasus X engines and was a biplane. This model is now obsolete and is no longer in production, although a few examples of it are used for training work.

The current Saro flying boat is the Lerwick, in which Mr. Knowler, the firm's chief designer, departed considerably from what had been common practice up till the time of its introduction.

The hull of the Lerwick is relatively narrow, but very

The Miles Master (Kestrel XXX) is an advanced trainer with very distinctive features.

deep in order to give adequate clearance for the airscrews. The two engines are Bristol Hercules, driving variable-pitch airscrews. Power-operated gun turrets are located in the bows and stern of the hull. Performance figures may not be published, but the Lerwick is one of the fastest flying boats in the world. Its wing span is 81ft.

Unusual features of the Lerwick (two Hercules) are the very deep hull and the small tapering wings.

SHORT

SHORT BROTHERS is a name which has been well and favourably known in British aviation since the earliest days of flying. The three brothers, Horace, Eustace, and Oswald, began their aeronautical career as makers of balloons. This was before aeroplanes were introduced. Then the Wright brothers began to fly, and the Shorts began to take an interest. Mr. Griffith Brewer introduced Wilbur Wright to them when he came to Europe in 1910, and they began to build Wright biplanes. Then they launched out on original designs, and in the war 1914-18 the "Short Two-two-five" seaplane was used extensively by the Royal Naval Air Service. It was one of the first seaplanes to be used for dropping torpedoes. Horace Short died during the last war, and Eustace passed out a few years ago just as he had landed his little seaplane on the Medway (he learned to fly when he was 60!), and was found dead in the cockpit, with the machine on the mud and the engine still running. Oswald Short is now the only surviving brother, and he has guided the fortunes of the firm ever since the death of Horace. That he has done so with wisdom is proved by the success which has followed the name of Shorts.

Many types of flying boat, military and civil, have been produced by Short Brothers, Ltd. It will suffice if we recall such names as the Calcutta, Rangoon, Singapore, Kent, "Knuckleduster," Empire boat, and Sunderland.

Of this long list, which is by no means exhaustive, the Sunderland is the current type (for the present). It is a direct descendant of the Empire boats, but the hull form has been changed, and, of course, the internal accommodation is less luxurious than that of the Empire boats, which were, by common consent, the most comfortable aircraft anyone could desire.

The Sunderland is fitted with four Bristol Pegasus XXII engines. It is designed for long-range reconnaissance, and also carries a large bomb load in the hull. Bunk accommodation is provided for the crew. There are power-driven gun turrets in bows and stern. The Sunderland has a wing span of 113ft. and a normal loaded weight of 45,700 lb. The "overload" gross weight (with which the boat gets off without any difficulty) is 49,870 lb., at which loading the maximum range is 2,500 sea miles. The maximum speed is 210 m.p.h. and the cruising speed 178 m.p.h.

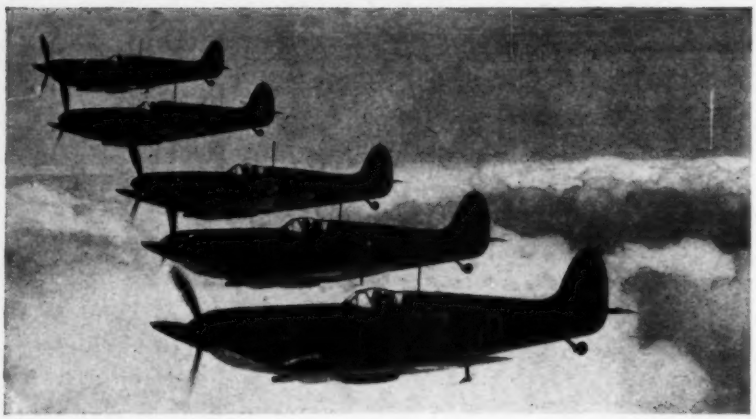
In the present war the Short Sunderland has given a very excellent account of itself. Its main duties are long-range patrols over the Atlantic and North Sea, and it has scored many successes. It has also rendered humane service by its rescue work. For instance, it may be recalled that a Sunderland rescued 34 members of the crew of the steamer *Kensington Court*. For this work Flt. Lts. Smith and Barrett were awarded the D.F.C.

The powerful armament of the Sunderland enables it to take good care of itself, and on one occasion, when it was attacked by six Ju. 88s, it shot down one and damaged another. For this exploit Flt. Lt. Phillips received the D.F.C. and Corporal Lillie the D.F.M.

Reference to the commercial Short boats *Clare* and *Clyde* should also be made. In spite of the absence of wireless guidance, owing to

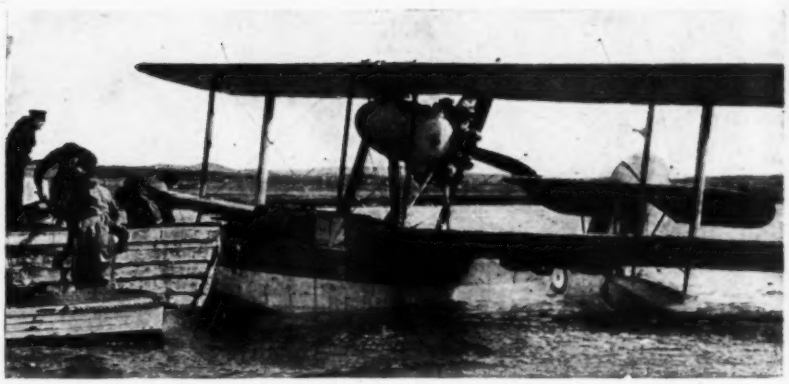
The Short-Mayo Composite (left). *Mercury*, the upper component, has four Rapiers, and *Maia*, the lower component, four Pegasus.

(Below) The Sunderland (four Pegasus XXII) taking off.



A formation of Supermarine Spitfire fighters. The engines are Merlins.

(Right) The Walrus, an amphibian pusher flying boat with Pegasus engine. It can be catapulted off.



war conditions, these two boats carried through the trans-Atlantic flights last summer. They are now being reconditioned and will be put on the Empire air routes.

Finally, it is worth remembering that Shorts built the two machines *Mercury* and *Maia*, upper and lower components respectively of the Mayo Composite aircraft. The *Mercury* made a record flight to South Africa and crossed the Atlantic non-stop. This form of assisted take-off is by no means dead, although its commercial application has naturally had to be shelved until better times.

SUPERMARINE

A FEW years ago the Supermarine Aviation Works, Ltd., and Vickers (Aviation), Ltd., were merged together under the general title of Vickers-Armstrongs, Ltd. In most people's minds, however, the two still remain distinct entities, and we prefer to deal with their products separately.

The name Supermarine has for close on thirty years been associated with marine aircraft—flying boats and floatplanes. Among the famous types were the many Schneider Trophy racers, culminating in the S.6B which won the trophy in perpetuity for Great Britain. Of flying boats one may recall the *Southampton*, and in more recent times the *Stranraer*. Each in its day rendered good service and made the name Supermarine respected in all corners of the globe.

In the present war it has so happened that it is a landplane and not a flying boat which has upheld the Supermarine tradition. The Spitfire fighter has caught the public imagination to a greater extent than has any other aeroplane, and Spitfire Funds have sprung up all over the world.

The Spitfire (Rolls-Royce Merlin) is our fastest single-engined fighter, with a top speed of 367 m.p.h. at 18,000ft. Its armament includes eight Browning machine-guns housed in the wings.

Spitfire successes in the war have been too numerous to mention. Sqn. Ldr. Farquhar, D.F.C., of the Auxiliary Air Force, shot down the first raider to fall on British soil. That was on October 28 last year. He was flying a Spitfire. The type came into large-scale use at Dunkirk, and took a large part in the record scrap in which some 200 enemy raiders were brought down in one day.

A type which is in current use in the Fleet Air Arm is the Walrus. This is a single-engined amphibian flying boat, with a Bristol Pegasus engine driving a pusher airscrew. In addition to being amphibian, the Walrus is also capable of being catapulted from ships of the Navy. This machine, under the name Seagull V, is also in use in the Royal Australian Air Force.

VICKERS

FOR very many years—in fact, ever since the last war—Vickers bombers have been in continuous use in the Royal Air Force. In 1918 it was the Vimy with two Rolls-Royce Eagle engines (it was on a machine of this type that the late Sir John Alcock and Sir Arthur Whitten-Brown flew across the Atlantic in 1919). Afterwards we had Virginias and others.

All these types of heavy bomber were lightly loaded biplanes, and consequently slow, although they certainly carried a large military load. Then along came Mr. B. N. Wallis, from designing the Vickers airship R.100, with fresh ideas on aircraft structural design. He was given a drawing office separate from Mr. Rex Pierson's main design office, and set to work to evolve the geodetic type of construction. Mr. Pierson continued to produce "orthodox" designs, and when Mr. Wallis had advanced far enough with establishing the general principles of geodetic construc-

The Vickers Wellington bomber has two Bristol Pegasus XVIII engines. The machine is of geodetic construction.

A Vickers Wellesley (Pegasus) of the type which set up a world's record of 7,158 miles, non-stop.

tion, the two designers collaborated in producing an aeroplane. The specification selected was a difficult one, and geodetic construction was not carried to its full extent in it.

The first "all-geodetic" aeroplane to go into service was the Wellesley, with Bristol Pegasus XX engine. The machine was a two-seater long-range bomber, torpedo carrier, and general purpose monoplane. It will still be recalled that three of these machines made an attempt at establishing a new world's record. Two flew from Egypt to Australia, a distance of 7,158 miles. The third alighted in Batavia, but joined the others afterwards. The Wellesley is still in service in the R.A.F., and last week we published the first picture of it dropping a torpedo.

In the Wellington, a much larger machine, geodetic construction shows up to even greater advantage, and in the present war large numbers of this type have been in service and have acquitted themselves in a manner worthy of the Vickers name. Quite early in the war Wellingtons raided Kiel and Heligoland. About a year ago German warships were attacked and two cruisers were hit. The squadron was led by Sqn. Ldr. Kellett, D.F.C., A.F.C., who was, it may be remembered, the leader also of the record-breaking flight of the Wellesleys to Australia. Wellingtons also made numerous raids on Stavanger in the days when we were trying to make that town untenable. In May of this year a Wellington of a New Zealand bomber squadron made a reconnaissance flight from Scotland to Narvik, down the Norwegian coast and back to Scotland. The machine had been fitted with long-range tanks, and the flight lasted 14½ hours. It was also a Wellington which dropped the big bomb on the Munich *Bierhaus*.

The Wellington has a wing span of 86ft., a wing area of 750 sq. ft., and a normal gross weight of 24,850 lb. Its top speed is 265 m.p.h. at 17,000ft., and its maximum range 3,200 miles at 180 m.p.h. The service ceiling is 26,300ft. The engines are Bristol Pegasus XVIII.

WESTLAND

ORIGINALLY a branch of Petters, Ltd., Westland Aircraft, Ltd., is now an entirely separate concern. The firm has always been noted for its experimental work on unorthodox lines, and a Westland aeroplane is never of stereotyped design. The modern Westland designs are the joint work of Mr. W. E. W. Petter, technical director, and Mr. A. Davenport. The Westland type of the war (up till now) is the Lysander army co-operation monoplane. The first machines had the Bristol Mercury XII engine, but later versions have the sleeve-valve Perseus XII.

The Lysander is a high-wing monoplane, in which the pilot's view is exceptionally good. It has Handley Page leading edge slots and trailing edge flaps linked together, the speed range being very wide (50 to 230 m.p.h.). Service ceiling, 26,000ft.

At the time of our withdrawal from France, Lysanders did magnificent work in dropping supplies and ammunition to the retreating army. At the present time it is doing very different, but no less important, duties at home, but of these nothing may be said for the present.

Westland Lysanders. Bombs or containers with supplies can be carried on the undercarriage.

Topics of the Day

ASSISTED AND RESTRICTED

A Word or Two About Runways, Assisted Take-Offs and Kindred Subjects

By "INDICATOR"

WHEN this war is over and we get back into our civilian stride, with real airlines going to real places, we shall, I hope, have obtained a wealth of experience of aerodrome surfaces, runway technique, tricycles, and assisted take-offs. Just at the moment we are, I feel, at a parting of the ways. Wing-loadings and so on have gone up, but until now we have been able to cope with things in the good old way. With greater performance there are likely to be vital changes, if not so much in the facts at least in our outlook.

Before we can go very much farther someone must develop a really practical means of assisted take-off, and all our ideas of aerodrome surfaces must suffer some drastic changes. With heavy bomb-loads and comparatively inexperienced pilots, the word "practical" means that any system which is, or has been, developed will be immediately applicable to peacetime work, for the simple reason that if it is practical enough for such conditions it should be safe enough for passengers—and, more important, comfortable enough for them.

In the meantime, with the English winter to force the hands of Works and Bricks, more and more pilots are becoming used to concrete or other runways, and are finding that the business of taking off slightly across wind and of aiming a machine so that it hits the runway fair and square is not nearly as difficult as people originally imagined. It is no longer a secret that dozens of aerodromes in this country have been modified or originally laid out during the past summer with such aids to winter work, and it has been found that high wing-loadings and big take-off power has reduced the necessity for considering wind-direction very much.

Only Two Runways

At one time people thought that some four or five different runways were absolutely essential for continued operation, but now it has been found that two, if not ample, are at least all that are necessary for day-to-day operations. Always provided, of course, that one of them is reasonably designed to be used in the prevailing wind.

Even with the present-day machine it is not practical to take off half across a 50-m.p.h. wind. The difficulty of holding the machine across wind—necessarily on the brakes and engines—during the early part of the run is too great, and the tyres are not designed to stand up to the heavy side-stresses imposed during the landing. It is hardly practical nowadays to carry out a drift landing and so reduce the actual wind effect, since both rudder and ailerons usually fade out at quite a high speed. The artificial counter-drift cannot, in fact, be held up to the moment of touching down, and the squeal of the tyres must be heard to be believed even when one is landing quite normally with ten tons or so of flying machine. Incidentally, it would help the tyre manufacturers quite a lot if means were devised for rotating the wheels to landing speed just before the machine touches the ground. Most of the normal stresses are incurred by the simple reason of the fact that the wheels must be accelerated more or less instantaneously from 0 to 70 m.p.h.

Curiously enough, the trouble with the old grass type of aerodrome during bad weather is not nowadays so much the old one involving the risk of nosing machines over in mud and water, but simply that with so much effective resistance machines cannot be made to leave the ground. The high-efficiency type requires a ground speed of very little short of 80 m.p.h. before it can safely be taken into the air, and such a speed demands a good deal of extra power over ground which is wet and soft. In fact, it is a somewhat terrifying experience to be half-way across an aerodrome with a machine still doing only some 50 m.p.h. and showing no signs of going much faster. It is then too late to shut down and give it up, and impossible to force the machine into the air at a ridiculous angle from which it will never recover and at which absolutely no aileron control is available.

If it was just a matter of failing to gain speed it would be a fairly simple matter, and you know quite early enough to take action that nothing very much was going to happen in the way of flying. The trouble is that the machine usually goes quite well over the initially chosen area of good ground, and then slows up as it ploughs through a mass of mud. The latter, too, covering the leading edge, does not improve the aerodynamic qualities of the outfit.

Mud, Water and Take-offs

The unhappiest part of the whole thing is that while superior people in other parts of the world tend to laugh at our grass aerodromes, there was—and for that matter still is—very good reasons for this type of landing ground. They are comparatively cheap to lay out and can usually be produced more quickly than really adequate runways. More important, they are kind to the machines. It is all very well to talk glibly of runways, but anyone who has heard the tyres of a really large machine screaming as they touch the concrete or tarmac will know something of the stresses imposed—and very few landings are made exactly into wind. Grass is resilient in the horizontal plane, and turf in the vertical plane. There is nothing to beat grass in a country where it can easily be produced.

The trouble occurs and the mistakes have been made in endeavouring to give way entirely to the passion for turf. There are quite a number of aerodromes where no attempt should ever have been made to produce "normal" surfaces, but where work should have been started at the very beginning on runways. And, what is more, on runways laid a little higher than the surrounding turf so that they could never be flooded. Let there be no mistake; there is very little difference in the resistance of six inches of water on concrete and on turf—if the latter has a hard crust. Unfortunately, a hard crust usually means that the surface water has no possible means of getting away, and the different soft patches are most effectively hidden until that awful moment when the tail goes up and up with the stick hard back, and the engine still giving +12 boost to no avail. The machine rarely appears to go right over, though the airscrew tip is sometimes damaged, but running out on dry ground sends the machine rocketing up in a power stall, to fall back with a most undignified crack before leaving the ground more normally.

Design for Landing

Although I believe most thoroughly in the level-landing principle—and for that matter in the level take-off principle—I do not believe that the non-conventional tricycle is the final answer. Nevertheless, the tricycle is the thing we have at present, and this device is most unhappy on soft turf, whether covered with water or not. If anything spells the end of the doubtful turf aerodrome it is the tricycle landing gear. This device also, fortunately enough, makes an end of the necessity for multiple landing directions. With it, it is only necessary to produce a couple of good mile-long runways so long as the brakes—that is, the steerable part of the braking system—continue to work. When someone has produced a steering system which does not involve braking on alternate wheels, even this braking business will not be all-important, though useful as a means of correcting approach judgment.

Someone ought to produce a guide to thought for aeroplane and aerodrome designers. One can talk vaguely about it for ever, but war demands something which more nearly resembles action—a thing very difficult to produce with only a pen or a typewriter.

NEWS from AUSTRALIA

Scientific Work : More Consolidateds : Gipsy Engines

SOME progress is being made in aeronautical research work under the Council for Scientific and Industrial Research (C.S.I.R.), the laboratory now being constituted the Division of Aeronautics and taking its place alongside the other Divisions of Animal Health and Forest Products. Mr. L. P. Coombes, formerly of Farnborough, is in charge.

The aerodynamics section has nearly completed its wind tunnel, but the supply of motor and airscrew from England may be delayed. The engine section has its C.F.R. engine for fuel research, and the structures and materials section has all its testing machines calibrated and working. Problems which are at present being worked upon are the use of an Australian timber for use in aircraft and the manufacture of Australian plywood. This is likely to be a fruitful subject for research as already there are difficulties about the supply of light alloys from U.S.A. and thoughts are turning to timber.

A research officer of the New South Wales Forestry Commission commented on the tests of local timber thought likely to be of use in aircraft production. A wood had been found which was a little heavier than imported spruce but was mechanically better. Large supplies were available, and it could be obtained in logs up to 60ft. long. It was one of the lowest-priced timbers on the market. The Air Board has asked the Aircraft Production Commission if it would be practicable to build a wooden twin-engined training aeroplane in Australia, to supplement supplies of aircraft from overseas.

A re-classification of positions has been made in the Department of Civil Aviation. Unofficial sources state that the position of Chief Aeronautical Engineer (which corresponds closely to the former Superintendent of Aircraft) carries a salary of £A900 and is charged with the responsibility of directing the inspectors and aeronautical engineers. These latter are graded into two classes, with ranges of £A510-582 and £A420-510. A senior is in charge of them, with a salary of £A636-708.

In charge of the inspecting staff is a supervising inspector on £A582-660. Senior inspectors' salaries range between £A474 and £A546. The Chief Electrical Engineer, who deals with all radio equipment and related matters, receives £A1,100, with two assistants, each on £A900.

At June 30 the following licences were in force in Australia: Private pilots, 1,225; commercial pilots, 324; flying instructors, 87; navigators, 85; first-class radio, 20; second-class radio, 20; third-class radio, 52; ground engineers, 651; aircraft registration certificates, 332; aircraft airworthiness certificates, 261; aerodrome licences, 240 (in addition to which the Government provides 268 aerodromes, landing areas, flying boat bases and emergency alighting areas).

An order for another 11 PBY2s has been placed with the Consolidated Aircraft Corporation by the Government for the R.A.A.F. Extremely useful for coastal patrol work, these boats are intended to "replace" the Sunderlands which were about to be flown to Australia at the outbreak of war. The first order was for seven, and the end of this year has been spoken about as a possible date of delivery.

Australian-built Gipsy Engines

With the delivery by General Motors-Holden of the first twenty Gipsy Major engines for the DH Tiger Moth primary trainers, the first stage in the production of 500 of these units has been achieved in Australia. Only production men can realise the tremendous effort behind this achievement by the contractors and sub-contractors in several States, in the manufacture of over 500 different items for the engine in a very short time.

AUSTRALIA'S AERONAUTICAL LABORATORY: The newly completed building of the Aeronautical Division of the Council for Scientific and Industrial Research, at Melbourne.

This new development in Australian industry has called for the conversion from an automobile technique to that of aero engine precision, and some idea can be gleaned of the immensity of this task when it is learned that an agricultural implement manufacturer produced the camshaft. This camshaft is hollow and the manufacturing operation is similar to that required for the production of rifle barrels. With the aid of munitions engineers, this firm produced a praiseworthy job.

Every part of the engine is subjected to a critical examination before it is passed for assembly. The crankcase is X-rayed for material segregations, casting faults and internal cracks. All parts are put through an electric crack-detector for surface cracks, while one engine in fifty undergoes a fifty-hour type test on the bench. This engine is then completely dismantled and checked, reassembled, and given one hour's acceptance test before delivery.

An outstanding achievement in the production of this Gipsy engine in Australia was the connecting rods. These were a perfect job, and were the first of their kind ever commercially produced in Australia, being a machined aluminium-alloy forging. All this work has been developed and produced in about a year, without the full range of manufacturing equipment being initially available in Australia, and this is a commendable achievement.

Around Australia

A Brisbane business man, wishing to fly round Australia, left Sydney by flying boat on the first stage of his trip. He was accompanied by his wife, who acted as his secretary. His schedule was:

Sydney-Darwin by Qantas Empire flying boat (2,384 miles), Darwin-Daly Waters by Guinea Airways (328), Daly Waters-Wyndham by MacRobertson-Miller Airlines (524), Wyndham-Perth by MacRobertson-Miller Airlines (1,903), Perth-Melbourne (1,809) and Melbourne-Sydney (440), both by Australian National Airways.

In circumnavigating Australia by air a distance of 7,388 miles has to be covered. At Darwin, passengers now have much better accommodation as the new hotel, which has some affiliations with one of the airlines, is now open.

C.O.D. in the Outback

A little discussed, but highly important, service to the outback districts of Queensland and Northern Territory is the C.O.D. system which Qantas has successfully carried on since the early days of the company. By this method people living in country centres are able to order from the large city houses of Brisbane and Sydney, and Qantas not only delivers the parcels at destinations, but collects the cash through its many agencies, and finally settles with the despatching firm.

Lady purchasers can buy the very latest models in shoes and frocks and obtain delivery within a few days. Developing with the years, figures for the past 12 months show that over 1,000 items, to the value of about £3,000, were handled in that period.

STRATOSPHERE ATTACK

A Neglected Study : Germany's Plans : Pressure Suits and Pressure Cabins : The Supercharger Problem

By NOEL PEMBERTON-BILLING

The following article is a condensed version of a chapter from a book which is to be published shortly. The book will deal exhaustively with the whole subject of air attack and defence, but we have selected the chapter on high-altitude flying because we feel that this is one phase which is likely to become important before long.

The author seems to be less than fair to British designers, particularly when he criticises them for tardiness in adopting new ideas. After all, designers produce that for which there is a demand, and which their directors tell them to produce. Rather than blame designers, Mr. Pemberton-Billing should, we think, attack Air Ministry policy. If high-altitude flying is wanted, British designers will produce the machines. It was not their fault that the pressure-cabin machines of Faireys and Shorts were dropped at the outbreak of war.

THE course of the air war so far has demonstrated that the fighter can beat the bomber whenever it can sight it. The German daylight raids on this country have shown that bombers flying at normal speeds and normal heights will suffer prohibitively heavy losses, and the virtual suspension of daylight attacks by the R.A.F. is an equally certain admission of this truth.

There are only two ways in which the bomber can continue to be used by daylight without these prohibitive losses. One is by gaining speed to such an extent that it becomes faster than the opposing fighters. The other is by gaining height to enable it to fly above them. Even if it cannot get above their absolute ceiling if it is very high, the time taken by the fighters to get up to it will be long enough to enable it to escape, particularly as its arrival will not be heralded by any warnings. The arrival of the bombs themselves will be the first intimation of its presence, and if the fighters do not leave the ground until the bomber is overhead, it will be most of the way back to the Continent before they have reached even 35,000ft.

If we are to continue our excellent policy of attacks on specific military objectives, *our* only course is to develop the small fast dive-bomber that gains immunity from its speed, and uses assisted take-off to carry big bomb loads. For the Germans, whose bombing policy is more directed towards indiscriminate terrorisation of the populace, the high-flying bomber may appeal.

Stratosphere Rumours

There are increasingly persistent rumours coming out of Germany regarding the development of bombers capable of operating in the sub-stratosphere. It is known that extensive experiments in high flying, ostensibly for commercial purposes, were carried out in Germany before the commencement of the war. Italy has always shown great interest in the high-flying aeroplane, and holds the present world's altitude record of 53,000ft. An ability to turn the achievements of science to immediate and effective military use has always been one of the acknowledged characteristics of the German. It seems inevitable, therefore, that the attraction of bombing England from the stratosphere would be quite irresistible, particularly as Goering's other methods of aerial attack have not so far achieved anything like the success that was expected.

Very little had been done in this country, prior to the war, in developing the practical aspect of high flying. As usual, America was doing it first, and we were still in the stage of amused apathy that always precedes our later frantic attempts to catch up with new American ideas. When both the nose-wheel undercarriage and pressure cabins were reaching the production stage in America, we were still in the process of proving that they were not worth the weight and complication, a process which must always be gone through with years of deliberation before the British designer can catch up with American ideas of a few years previously. From this comment we must exclude General Aircraft, who, though they possibly did little more than copy the Americans in experimenting with these ideas, at least did it with more alacrity than is usual in the British aircraft industry. Naturally, this had to be done at their own expense.

Not having ever reached the stage of building high-flying aeroplanes, the question of defence against them is naturally still one further stage away. If the enemy should develop a bomber capable of cruising over this country at 40,000ft., to say nothing of the less likely 60,000ft. mentioned in rumours, it will be able to shower its bombs on us with complete immunity. Neither searchlights nor guns can reach to this height, and their effect would still be negligible if they could. Nor are existing fighter aircraft of much greater value. Even if they can obtain warning of the enemy's arrival they cannot climb above their ceiling of about 35,000ft., and it takes them about half an hour to reach this height.

Some of the Problems

Is the construction of such bombers a possibility? To understand the problems of attaining such heights it is first of all necessary to have some appreciation of the various factors that tend to limit high-flying performance.

The atmosphere gradually gets thinner as height increases, until at 20,000ft. its density is only half that at sea level. As the height increases still further, the air becomes even thinner, and at 50,000ft. it is little more than one-tenth of the density at sea level.

There is a certain similarity between the pilot and his engine, in that both of them need oxygen to be able to function, and as the air gets thinner both are affected by the lack of it. It is necessary to supercharge both the engine and the pilot to an increasing extent as they climb. Provided he is not required to do anything energetic, a man can continue to breathe without any additional oxygen up to a height of about 15,000ft. The engine also can continue to run up to even greater heights, but naturally its power is reduced in proportion to the height; so that an unsupercharged engine will give only about half its sea-level power at 15,000-20,000ft.

"Supercharging" the pilot is a comparatively simple matter. Up to 40,000ft. it is merely necessary to give him pure oxygen, but at heights above this, allowance

STRATOSPHERE ATTACK (CONTINUED)

must be made for the effect of the reduced pressure outside on the whole body of the pilot, which gives a "bursting" tendency. Early balloonists attempted to protect themselves by binding themselves all over with tape. Nowadays it can be overcome either by providing the pilot with a pressure suit, something similar to those used by deep-sea divers, but for the opposite reason; or in the case of a larger aeroplane with a crew, a pressure cabin in which they can move about.

These devices have been tested in laboratory decompression chambers up to pressures equivalent to heights of 80,000ft. A height such as this is considerably greater than it would appear possible to fly from considerations of the engine and aeroplane, so that it is these latter problems that decide the limits rather than the effect on the pilot.

An engine will maintain its full power high up only if it is supercharged to supply as much air to the cylinders as they would normally receive at sea-level. Consequently, the higher the engine is required to go, the larger and more powerful must the supercharger be until, for very great heights, its weight and power consumption become so great that they may in themselves provide the limit to any further increase.

Two Possibilities

In discussing the probable dangers from high-flying attacks there are two possibilities to be considered. One is that of the construction of comparatively low sub-stratosphere machines on the lines of those already coming into use in America for commercial purposes. The second concerns less certain experiments in flying at altitudes of 50,000-60,000ft.

Pressure cabin air liners have been developed in America in order to allow commercial services to operate in greater safety, well clear of both bad weather conditions and the Rocky Mountains. The advantages of "over-weather" flying apply equally to its military use, together with the even more important advantages of immunity from attack. American aeroplanes have already demonstrated their ability to cruise at heights up to 30,000ft. with passengers in the pressure cabin, and there would not appear to be any difficulty in constructing a bomber to operate at this height.

The reduction in resistance at these heights would give it high speed which, together with the height, should obviate the need for any military armament. It is this question as to whether or not armament is to be carried that mainly decides whether the crew are to be enclosed in a pressure cabin or whether, in order to enable openings to be made for the guns, each one has a separate oxygen mask connected to a central reservoir.

Large Aeroplanes

It will not be possible to carry big bomb loads at great heights as fast as they can be carried lower down by the use of high wing loading and small, fast bombers. One needs a bigger wing to carry the same load. This means that the large four-engined type of bomber is most likely to be developed for this type of work. An existing German type which might possibly be adapted for this job is the Focke-Wulf "Condor," which was originally designed as an air liner, and has been used for transatlantic flights by Luft Hansa and, more recently, for raids on shipping. If its 720 h.p. engines were replaced by more modern 1,200 h.p. types, the speed at its present operating height of 13,000ft. would be increased from 233 m.p.h. to about 280 m.p.h., and if these engines could be supercharged to maintain their full power at 30,000ft., the maximum speed at this height would be about 320 m.p.h.

For the comparatively short trip from France to England, this machine could carry at least 6,000 lb. of bombs, which is considerably more than that carried by the Heinkel III, the largest type yet used by the *Luftwaffe* in bombing England. Very big bombers have not been used to any extent in the war so far because they are too easily shot down, but the development of sub-stratosphere flying opens up new possibilities for their employment. This threatened combination of size and height means not only that bombs may come unheralded out of an empty sky, but also that they will be bigger and better bombs than any that have so far been received.

A Missed Opportunity

If we should wish to retaliate by carrying out similar raids over Germany, we shall be at a disadvantage in having very little practical experience on which to base the construction of such aeroplanes. It is very typical of the official attitude to all technical progress in this country that at the declaration of war all work was stopped on the big four-engined pressure cabin air liner that Fairey's were building. If this had been completed it would have provided the prototype for a sub-stratosphere bomber of greater performance than anything existing in Germany, being similar in outline to the Focke-Wulf "Condor," but more advanced in detail, and capable of carrying considerably greater load.

Two of the most important difficulties that have been discovered in experiments at great heights have been the impossibility of preventing petrol evaporation at such low densities and low temperatures, and also trouble with spark ignition. Whilst these things have caused trouble at the heights already in use in America, they become most serious at even greater heights.

The Diesel

It is very significant, and for our purposes very unfortunate, that Germans are the only ones to reach the successful production stage with heavy-oil compression-ignition engines. The enemy is thus in the fortunate position of having ready to hand the ideal engine for this type of operation. The continual agitation for further research on the compression-ignition engine in this country had little result, though its commercial advantages for long-distance flying would have justified the research without its wartime possibilities.

A certain amount of private research has been made, and in America the Guiberson Diesel seems to be showing great promise; so that even now it is not too late to catch up, if for once the Air Ministry can be persuaded to look more than nine days ahead and stop running the Air War on the assumption that it will all be over in a couple of months. Otherwise it may be.

Before going on to discuss the possibilities of aeroplanes to fly at the even greater altitudes of 50,000-60,000ft., it is of interest to investigate the problem of defence against sub-stratosphere bombers of the type mentioned above, which can be assumed to be operating at heights of about 40,000ft.

Much depends on whether the aeroplanes employed have a pressure cabin for the crew, or individual oxygen equipment. For heights of this nature, the latter seems much more likely, as it is quite possible to exist with no more than a supply of pure oxygen up to even greater heights. The pressure cabin is naturally much more

STRATOSPHERE ATTACK (CONTINUED)

healthy and comfortable, and is essential to commercial operation, as passengers would not be willing to endure the discomforts and dangers of the rarified atmosphere.

But for military purposes the pressure cabin has certain serious disadvantages. First of all, there is the question of vulnerability. If the cabin were sprayed with machine gun bullets, or holed with a shell gun, the leak would cause a rapid drop in pressure and the crew would be forced to resort to emergency oxygen masks. Another disadvantage of the pressure cabin is that, as it is impossible to have any holes in it, it is impossible to carry gun positions. Although this may not be necessary with our defences in their existing state, it is possible that the enemy will give us credit for succeeding in the search for an adequate defensive aeroplane, in which case the armament will be more desirable.

In any case, if armament is not carried, the number of the crew required will be only two, or at the most three, so that the expense and difficulty of building a small pressure cabin to contain them seems hardly likely to appeal to the economical Germans. In any case, they will not normally be required to stay at these heights for very long periods. On leaving their bases in France or Germany they can gradually climb as they fly on their way, not reaching their maximum altitude until they are over the British coast. Then, after dropping their bombs, they can go downhill on the way home, thereby greatly increasing their speed.

So far as heights of around 50,000 ft. are concerned, there is less definite knowledge. To fly at such heights will require fairly low wing loading, and the aeroplanes will be flying right at their ceiling, which will vary considerably with their weight, so that it is most desirable to attack them before they drop their bombs. The only comfort that I can give to those who realise the dangers that lie in the stratosphere is that, unless the enemy can carry fairly big bomb loads, stratosphere bombing is useless, and getting big loads up there is going to be very difficult.

The problem of finding a defence against the high-flying bomber is one to which I have given considerable thought, for I believe it to be the next big defence problem with which we will be faced. A system of defences which I believe will go a long way towards solving the problem will be the subject of a further article. There are, I admit, difficulties, but if the enemy can manage to overcome the difficulties of attack, we must apply ourselves most urgently to overcome the difficulties of defence. In fact, we must anticipate them.

As far as our own attack on Germany is concerned, development of indiscriminate stratosphere bombing should not be necessary if we can build fast daylight dive bombers that get immunity through their speed, and enormous punitive power through assisted take-off. If they can be backed up by efficient secret service reports, another department where the Germans appear to be more successful, to know when and from where the Germans are starting their raids on this country, then the most effective defence will be to attack them before they have left their bases. Let us hope that the problem is appreciated by those whose job it is to defend the country, so that they will not have to call upon the people to suffer in silence once more because we were not prepared.

MODERN TECHNICAL DEVELOPMENTS

TOTAL ENERGY VARIOMETER

WHEN a sailplane is zooming or diving, it is gaining or losing altitude energy at the expense of kinetic energy. It is, however, changing its total energy (altitude energy + kinetic energy) at a rate which depends only on its drag and atmospheric air currents. Thus, if we measure the rate of change of total energy instead of just altitude energy, we will have a measurement of atmospheric currents and sinking speed independent of the glider's attitude. Furthermore, total energy is the quantity in which the soaring pilot is interested in increasing. The total energy of a plane of mass m flying at a velocity v at an altitude h is $\frac{1}{2}mv^2 + mgh$, and it is thus proportional to $\frac{1}{2}v^2 + gh$.

In the usual design the atmospheric outlet of the variometer is connected to the static head where it is exposed to the altitude pressure—ρgh (ρg is the density, h the altitude, and pressure is measured from sea level pressure). Now, consider the variometer outlet to be connected to the throat of a venturi with a contraction ration of $\sqrt{2}$, which will produce a pressure drop equal to the dynamic pressure $\frac{1}{2}\rho v^2$. In this case the variometer will be exposed to a pressure $-\rho gh - \frac{1}{2}\rho v^2$ also proportional to $\frac{1}{2}v^2 + gh$, the measure of the sailplane's total reserve of energy. Therefore, if connected in this manner it would read rate of change of total energy in altitude units. A variometer so connected may be called a "total energy variometer," and it should be possible to measure upward air currents, even in rough air, without corrections.

"Total Energy" Variometer for Detecting Upward Currents in the Atmosphere. (A. Kantrowitz, J. Aeron. Sci., Vol. 7, No. 12, Oct., 1940, p. 523.)

PETROL INJECTION

CARBURETTOR has been developed to eliminate icing hazard, gravity and inertia effects as well as vapour lock tendencies. At the same time, it is claimed that mixture control is rendered more accurate. In the usual type of carburettor, the petrol enters the air stream in the region of the choke tube, the fuel-air mixture subsequently passing the throttle, which is thus liable to freeze up unless special precautions are taken. In the new design the petrol is delivered under positive pressure by means of a pump to a point above the throttle, the flow being governed by a diaphragm subjected to the choke depression and operating valves in the fuel pump delivery circuit. The second diaphragm is placed in this circuit in order to damp out pressure variations of the pump. A by-pass circuit from the pump casing back to the fuel tank eliminates any fuel vapour that might upset the metering characteristics. With this new carburettor the pilot may select at will any fuel-air ratio for a variety of operating conditions, such as lean cruising, rich cruising, and full rich for take-off.

The desired fuel-air ratio is held constant by a special automatic mixture control unit which compensates for changes in air density and temperature. Nevertheless, the entire engine power can be used at all positions of the mixture selector lever. The regulation of the manifold pressure is not automatic in the models available but must be effected by the throttle at all times.

Bendix-Stromberg Injection Carburettor. (Inter Avia, No. 723, Aug. 19, 1940, pp. 1-4.)

(Abstracts prepared by and made available by courtesy of R.T.P. of the Ministry of Aircraft Production.)

NEW BRITISH AIRCRAFT

An Amazing Position : U.S.A. Public Informed of Names and Character of "Secret" British Aircraft and Aero Engines

IN this issue, the annual British Aircraft Number of *Flight*, the range of aircraft and engines in service is reviewed and illustrated. The review is as up to date as is possible in view of restrictions we apply in wartime and Air Ministry regulations which we attempt faithfully to interpret. None the less, our readers will share with us astonishment mingled with disgust that what the American public are allowed to know of our "secret" and new types soon to come into service is withheld from British readers, many thousands of whom are in the R.A.F. and Fleet Air Arm.

A month ago an American aviation journal published and named by type a list of new military aeroplanes in production in this country, designed to supplant existing types. The writer also gave the characteristics of new and larger aero engines, naming each one as well as the machines for which the engines are intended. Even the armament of our newest British fighter, not yet announced in this country, is revealed. It is no satisfaction to those patriotic journalists who know of these types, but can be relied upon to maintain silence, to see material of this kind publicly broadcast, even in a friendly country, since quite clearly there are various channels by which the information can be, and indeed most probably has already been, transmitted to our enemies. If the information is openly available to Americans it can do no harm to publish it here. Apparently official view is otherwise. *Flight* brought the article to the notice of the Air Ministry Censorship and requested permission to republish it in its original form. Permission was refused. This decision would imply that the transmission of the notes to our U.S.A. contemporary reveals a leakage of official information and its publication regarded as an unfriendly act, or, alternatively, that access has been obtained to secret lists and a breach committed in abstracting notes for publication which many air correspondents could have done if they ignored defence requirements and were indifferent to the consequences. Presumably an official enquiry will be instituted to clarify this ludicrous position.

"NOW EXCLUSIVELY ON WAR WORK"

Two Groups which Contribute Largely to Our Production

ON pp. *a*-499 we have dealt with the products of those aircraft manufacturers who are the "parent" firms of the British aircraft industry and who continue to design and build aircraft for use in the war. In addition to these there are, besides the thousands of large and small firms which contribute to the war effort by making accessories, equipment, parts and components, two distinct groups. The firms in the first group are those which were approved for design before war broke out; those in the second include the "shadow factories" and the numerous large motor firms whose works have been converted to the large-scale manufacture of aircraft and engines.

The firms in this second group are, of course, purely manufacturing concerns. They do not design the aircraft or engines which they build, but their purpose in the general scheme is to produce large quantities to designs supplied by the designing firms. It is, very largely, to these great manufacturers that the country looks for the vast output of airframes and aero engines which is to place us level with Germany in the matter of numbers. And right nobly have they responded. If it were permissible to quote figures, it would be found that their output, once the necessary jigs and machinery had been installed, and the workers trained in the new technique, is quite remarkable. It may be supposed that when the war is over and victory has been won, the large motor companies will revert to their original business of supplying the nation with cars which will by then be badly wanted.

The firms in the first group, although not, generally speaking, now designing service aircraft for war purposes, have been made full use of by taking advantage of their equipment and experience. They are mostly engaged upon sub-contract work for the other designing firms, although some, at least, continue to produce new designs. As these firms are likely, after the war, to continue where they left off, with probably a jump ahead as a result of their war-production experience, it is thought that a brief summary of their activities before the war may be of interest, and may serve to indicate what we may expect from them after the war. For convenience these firms will be mentioned in alphabetical order.

A.R.III Construction is the firm which built gyroplanes to the designs of Mr. Raoul Haffner. Another firm which designed and built unorthodox aircraft was M. B. Arpin and Co., who produced a two-seater cabin pusher. Chilton Aircraft had an intriguing little monoplane with Ford engine. In spite of its low power this machine flew very strongly. The Cierva Autogiro Co., Ltd., was world-famed for its rotating-wing aircraft, and it is to be hoped that the firm will resume, in connection with G. and J. Weir, Ltd., of Glasgow, the development of aircraft of this type.

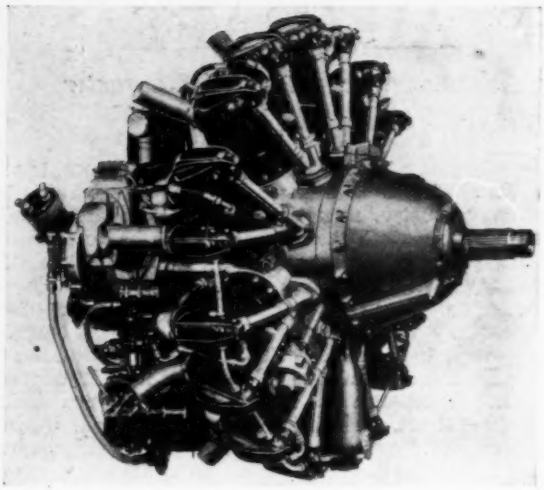
Cunliffe-Owen Aircraft, Ltd., built the Burnelly flying wing, of which more may be heard. The Deekay Aircraft Corporation had great schemes for using plastics in aircraft construction, and may have reached a practical stage when the war ends. Folland Aircraft, Ltd., was founded by Mr. H. P. Folland when he left the Gloster company. Several aeroplanes have been designed, including a commercial monoplane and some special aeroplanes for research purposes.

Foster Wikner Aircraft Co., Ltd., had a high-wing two-seater monoplane, the Wicko, which was promising well. The Heston Aircraft Co., Ltd., were developing the Phœnix monoplane, a very comfortable and quiet cabin machine with Gipsy Six, and had ready for test when war broke out a speed machine which was to have made an attempt on the world's speed record. F. Hills and Sons, Ltd., manufactured the Praga monoplane, but are now interested in compressed wood, and also, it may be remembered, the firm is building the Pemberton-Billing "slip-wing" machine.

Hordern-Richmond Aircraft had an unorthodox twin-engined monoplane with Continental engines, but shelved it in order to specialise on airscrew work. The Mayo Composite Aircraft Co., Ltd., designed, in conjunction with Short Brothers, the Short-Mayo Composite aircraft. It may be assumed that Major Mayo is developing the scheme for future application. Moss Brothers Aircraft, Ltd., produced an interesting little trainer monoplane with Cirrus Minor engine, and Tipsy Aircraft, Ltd., were putting into fairly large production the snappy little Tipsy monoplane. Reid and Sigrist, Ltd., in addition to their various instruments, had produced the twin-engine military trainer. Owing to the outbreak of war, this did not go into production.

THE AERO ENGINE

An Essential Link in the Chain



The small over-all diameter of 41.5in. is a feature of the Alvis Leonides 9-cylinder radial.

ALVIS

THE Alvis Leonides is what is called in these days a small 9-cylinder radial air-cooled, its take-off power being 450 h.p. It is also the only engine in the table which has its bore larger than its stroke (if the Dagger may be excepted, in which the two dimensions are very nearly equal). A gear box is provided for all accessory drives, and the two valves per cylinder are operated by independent, completely enclosed pressure-lubricated rocker gear.

Pelides is Leonides' big brother, and its 14 cylinders in two rows develop 1,060 h.p. for take-off.

ARMSTRONG-SIDDELEY

THE Cheetahs and the Tigers make up the Armstrong Siddeley range of air-cooled radials. The Cheetah IX and X are fitted in the Coastal Reconnaissance Anson (sometimes known as "the fighting Anson" for good reason) and the Airspeed Oxford. Both these engines are 7-cylindered, the Mark X being fitted for variable-pitch airscrews. Cylinders have steel barrels, light alloy heads and two valves. Take-off power is 360 h.p.

The Tiger VIII and IX with their 14 cylinders in two rows have more than double the volume of the Cheetahs, and develop 918 and 845 h.p. respectively for take-off. The Tiger VIII has a two-speed supercharger.

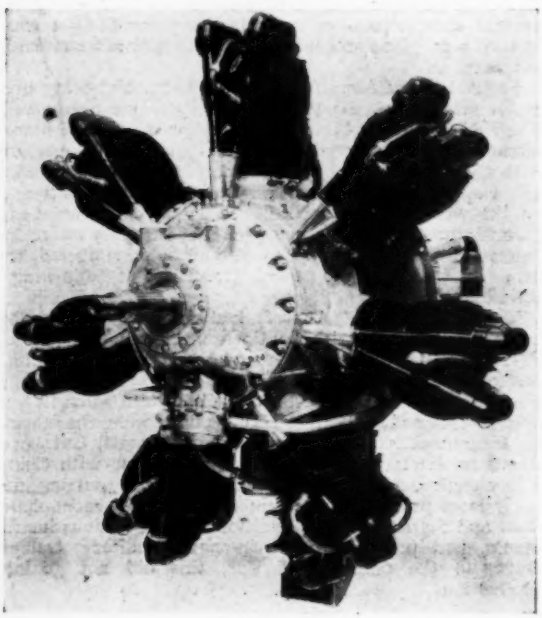
BRISTOL

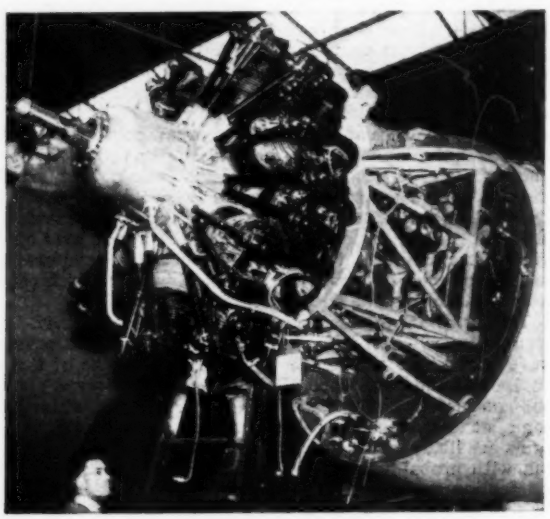
BRISTOL engines have been one of the mainstays of British aviation in both war and peace, and are now in enormous production in the parent and "shadow" factories. Pegasus and Mercury are famous names in the poppet-valve range, and the later sleeve-valve development in which Bristol leads the world carries the names of Hercules, Taurus and Perseus. The Pegasus XVIII has a two-speed supercharger and is the power unit for Wellingtons and Hampdens. The Blenheim IV L ("long nose") has a Mercury XV. Mercury VIII, IX, XI and XII and the Pegasus engines, except for XVII and XVIII, have a single-speed supercharger with take-off ratings ranging from 725 to 1,010 h.p. They are supercharged at various altitudes from 5,250 to 14,000ft.

The Perseus XII is a sleeve valve which is in wide use in the DH Flamingo and in the short trans-Atlantic and trans-Tasman boats in its civil-rated form, and in the Blackburn Skua and Roc and Westland Lysander under a military rating. The next larger sleeve valve, the 14-cylinder Taurus, is power unit for the Bristol Beaufort and the Fairey Albacore. Hercules, the largest of the sleeve valves, is also on war work, and can develop 1,380 h.p. from its 14 cylinders during take-off. Its international rating is 1,010/1,050 h.p. at 4,500ft. and maximum altitude rating 1,220 h.p. at 5,500ft. Since the outbreak of war developments have occurred in the Bristol range of engines but it is regretted that they cannot be published yet.

CIRRUS (BLACKBURN)

OF use in peacetime flying or wartime training, the Cirrus section of Blackburn Aircraft has two inverted four-cylinder air-cooled types, the 90 h.p. Cirrus Minor and the 150 h.p. Cirrus Major. The cylinder barrels are





(Left) The Armstrong Siddeley Cheetah X is installed in the Airspeed Oxford twin-engined trainer.

(Above) The Tiger VIII is another Armstrong Siddeley. It is a 14-cylinder two-row radial with a two-speed supercharger.

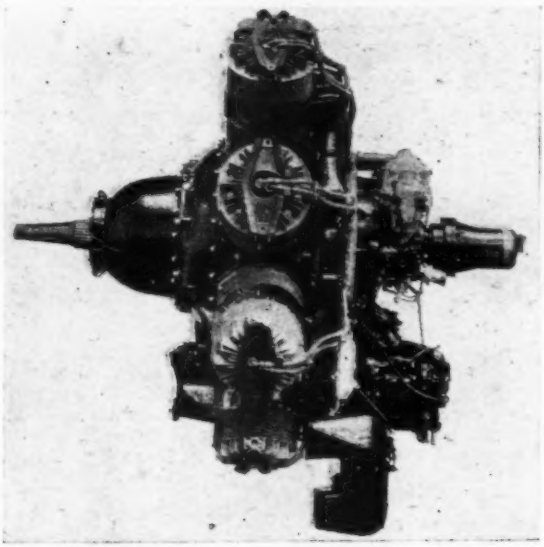
NGNES OF BRITAIN

k in Chain of Combat Strength

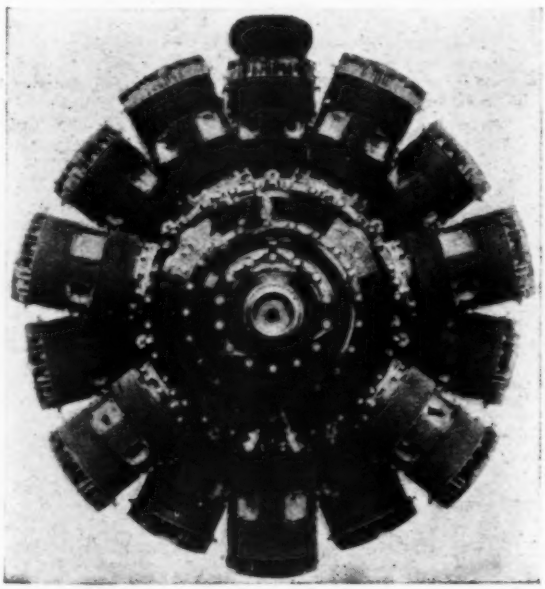
machined out of steel and the detachable head is a casting in Y alloy. The five-bearing crankshaft has a ball thrust bearing at the front end. A Claudel-Hobson carburettor and BTH electric inertia starter are fitted.

DE HAVILLAND

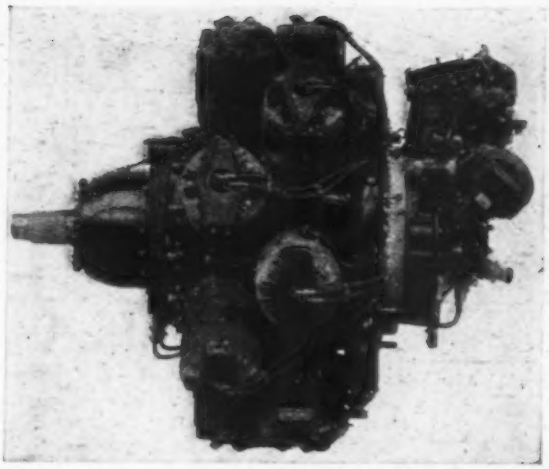
THE De Havilland series of Gipsy engines, designed by Major Halford, has won fame all over the world for its reliability. The series covers a power range from 100



The Perseus is a smaller Bristol sleeve valve which is in use in both civil and military craft.

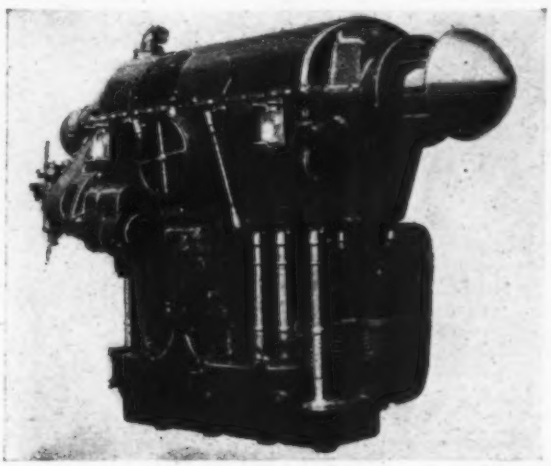


The giant of the Bristol engines, the Hercules IV sleeve valve, delivers 1,380 h.p. for take-off from its 14 cylinders arranged in two rows.

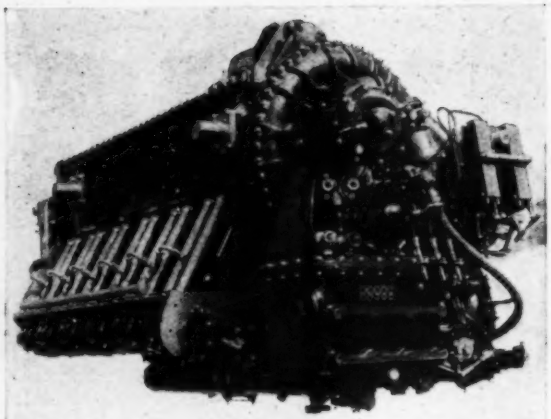


The Taurus is one of the unique Bristol range of sleeve valve engines. Its 14 cylinders give 1,010 h.p. for take-off.

The 9-cylinder Bristol Mercury is a famous name among poppet valve engines and is fitted to many R.A.F. aircraft.



The Cirrus Major is a neat in-line inverted four suitable for wartime trainers or other small craft.



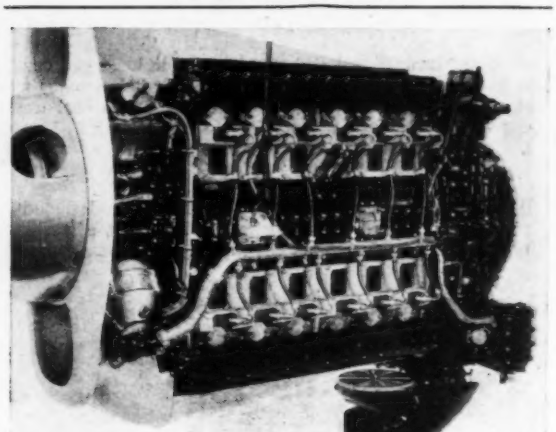
The latest and largest of the De Havilland range is the Gipsy Twelve, an inverted air-cooled vee which develops 525 h.p. at take-off.

The Gipsy Major has powered many aircraft. The Major II has a higher compression ratio and is designed for variable pitch airscrews and leaded fuel.

to 500 h.p. with its in-line air-cooled inverted engines. The Minor and Major are four-cylindered, the Six is self-explanatory and the Twelve is an inverted vee type. The Major II and the Six II both have the higher compression ratio of 6 and are fitted for variable-pitch airscrews.

Typical of Gipsy design is the Major. Its cylinder barrels are machined from carbon steel forgings with detachable heads of aluminium bronze. The crankshaft is a nickel-chrome alloy steel forging running in five main bearings with a ball thrust at the front. The crankcase is of aluminium alloy and the top cover of magnesium alloy.

THE AERO ENGINES OF BRITAIN (CONTINUED)



The Dagger VIII develops 1,000 h.p. out of a capacity of only 16.8 litres by reason of its high compression ratio of 7.5 and its speed of 4,200 r.p.m. It is a 24-cylinder air-cooled H type.

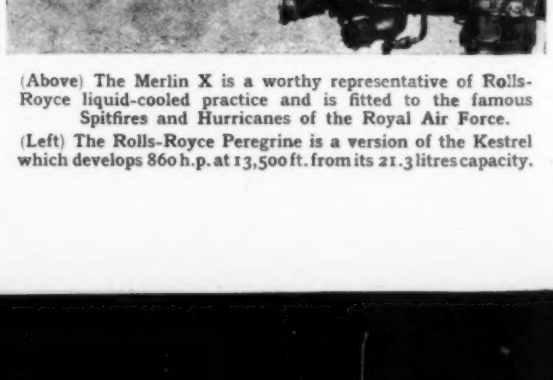
NAPIER

THE Napier Rapier 16-cylinder engine paved the developmental way for the 24-cylindered Dagger, both types being of H shape. Of the four air-cooled blocks of six, two are inverted and two vertical. The aluminium alloy crankcase is joined along the horizontal centre line, and there are two crankshafts running in bearings of lead-bronze. Valve tappet operation is hydraulic and there are four overhead camshafts.

ROLLS-ROYCE

FEW would quarrel with the dictum that Rolls-Royce holds world leadership in liquid-cooled engines. Representative of its two types of engine about which we may write are the Kestrel XXX which powers the Miles Master trainers and the Merlin X, which has borne the burden of a very great deal of the air fighting. This latter, with its two-speed supercharger, is a geared vee-twelve with cylinder capacity of 27 litres. (This is small compared to the German Mercedes-Benz DB 601A of 33.9 litres, which can only develop about the same power.)

The crankcase is an aluminium casting in two pieces, bolted together. The top half includes part of the reduction



(Above) The Merlin X is a worthy representative of Rolls-Royce liquid-cooled practice and is fitted to the famous Spitfires and Hurricanes of the Royal Air Force.

(Left) The Rolls-Royce Peregrine is a version of the Kestrel which develops 860 h.p. at 13,500 ft. from its 21.3 litres capacity.

gear casing, while the bottom lower half carries oil pumps, filters and drives for accessories. The auxiliary drive wheel case is fitted to a vertical facing formed at the rear end of the crankcase.

The crankshaft is a one-piece steel forging, nitrogen-hardened. H section connecting rods are fitted in pairs on the same crankpin, one being plain-ended and the other forked. All bearings are of lead-bronze. The cylinder banks are at an angle of 60 deg., and are of the monobloc type in aluminium with cylinder heads and water jackets in one casting. Steel cylinder liners are of the "wet" type. Each cylinder has four valves, the two exhaust having sodium-cooled stems.

Lubrication of big-end bearings is by pressure feed through the crankpins. A single-spur reduction gear transmits power to the airscrew. A cast aluminium reduction gear casing houses the forward roller bearings and is secured by bolts to the crankcase which houses the rear roller bearings.

The supercharger is of the high speed centrifugal type driven through a train of multiplying gears, fitted with a slipper mechanism. The two-speed drive is provided with a change-speed which is operated by oil pressure. Carburettor is of the twin choke type, of Rolls-Royce S.U. design. Two air passages are coupled by single forward facing air intake.

THE AERO ENGINES OF BRITAIN*

Tabular Summary of Main Characteristics

Maker's Name and Engine Type	No. and Arrangements of Cyls.	Cooling	Bore and Stroke	Capacity	Reduction Gear Ratio	Compression Ratio	International Rating			Maximum Altitude Rating			Take-off Power	Dry Weight
							Power	Engine Speed	Altitude	Power	Engine Speed	Altitude		
ALVIS			mm.	Litres			b.h.p.	r.p.m.	ft.	b.h.p.	r.p.m.	ft.	b.h.p.	lb.
Leonides	9 R.	A.	122×112	11.78	.5 / .63	6.3	435	3,000	8,250	440	3,100	9,000	450	708
Pelides	14 2-R.	A.	146×165	38.67	—	6	1,065	2,150	5,000	975	2,150	7,500	1,060	1,475
ARMSTRONG SIDDELEY														
Cheetah VA	7 R.	A.	133.3×139.7	13.65	D.	5.2	285	2,100	S.L.	326	2,400	S.L.	—	515
Cheetah IX	7 R.	A.	133.3×139.7	13.65	D.	6.35	310	2,100	6,000	350	2,425	7,300	340	635
Cheetah X	7 R.	A.	133.3×139.7	13.65	D.	6.35	325/340	2,300	6 750	355	2,425	7,000	360/375	694
Tiger VIII	14 2-R.	A.	139.7×152.4	32.7	.594	6.2	840 / 56	2,375 / 2,200	6,200 / 12,800 2-S.	862 / 782	2,450 / 2,450	6,600 / 15,000	918	1,290
Tiger IX	14 2-R.	A.	139.7×152.4	32.7	.594	6.2	775/805	2,375	6,250	810	2,450	6,500	845/880	1,260
BRISTOL														
Mercury VIII, IX	9 R.	A.	146×165	24.8	.572 / .50	—	795/825	2,400	13,000	840	2,650	14,000	725	1,005 (+5)
Mercury XI, XII	9 R.	A.	146×165	24.8	.50	—	780/820	2,400	3,500	890	2,750	6,000	830	1,005 (+5)
Pegasus XC	9 R.	A.	146×190.5	28 7	.50	—	710/740	2,475	3,500	830	2,600	5,250	920	1,030
Pegasus XXII, XXIII	9 R.	A.	146×190.5	28.7	.50 / .572	—	800/840	2,250	4,000	890	2,600	6,500	1,010	1,030 (+5)
Pegasus XVII, XVIII	9 R.	A.	146×190.5	28.7	.572 / .50	—	780/815 / 720/750	2,250	4,750 / 14,750 2-S.	1,000 / 885	2,600	3,000 / 15,500	965	1,130 (+5)
Pegasus XIX, XX	9 R.	A.	146×190.5	28.7	.572 / .50	—	800/835	2,250	8,500	925	2,600	10,000	835	1,130 (+5)
Pegasus XXV, XXVII	9 R.	A.	146×190.5	28.7	.50 / .572	—	795/830	—	11,000	915	—	9,500	830	1,035 (+5)
Hercules II	14 2-R.	A.	146×165	38.7	.444	—	1,100/1,150	2,400	5,000	1,375	2,750	4,000	1,300	1,680
Hercules IV	14 2 R.	A.	146×165	38.7	.444	—	1,010/1,050	—	4,500	1,220	—	5,500	1,380	1,680
Taurus II	14 2-R.	A.	127×137	25.4	.444	—	860/900	—	5,000	1,065	—	5,000	1,010	1,300
Perseus X	9 R.	A.	146×165	24.9	.50	—	700/730	2,400	14,500	880	2,750	15 500	750	1,110
Perseus XI, XII	9 R.	A.	146×165	24.9	.572 / .50	—	715/745	2,400	6,500	895	2,750	6,500	830	1,105 (+5)
Perseus XIIC, XIVC	9 R.	A.	146×165	24.9	.50 / .666	—	680/710	2,250	4,000	815	2,600	6,000	890	1,100(+10)
Aquila IV	9 R.	A.	127×137	15.6	.50	—	450/470	2,600	4,500	540	3,000	6,000	600	830
CIRRUS (Blackburn)														
Minor	4 I.L.	A.	95×127	3.605	D.	5.8	82	2,300	S.L.	90	2,600	S.L.	82	227
Major 150	4 I.L.	A.	120×140	6.33	D.	5.8	138	2,000	S.L.	150	2,450	S.L.	132	325
DE HAVILLAND														
Gipsy Minor	4 I.L.	A.	102×115	3.759	D.	6	80	2,250	S.L.	90	2,600	S.L.	80	210 (±5)
Gipsy Major I	4 I.L.	A.	118×140	6.124	D.	5.25	120	2,100	S.L.	130	2,350	S.L.	130	300
Gipsy Major II	4 I.L.	A.	118×140	6.124	D.	6	140	2,400	S.L.	140	2,400	S.L.	—	310 (±5
Gipsy Six I	6 I.L.	A.	118×140	9.186	D.	5.25	185	2,100	S.L.	200	2,350	S.L.	200	450 (±7½)
Gipsy Six II	6 I.L.	A.	118×140	9.186	D.	6	205	2,400	S.L.	205	2,400	S.L.	205	469 (±7½)
Gipsy Twelve	12 I.V.	A.	118×140	18.372	.667	6	405/420	2,400	7,500	410/425	2,450	7,750	525	1,058
NAPIER														
Rapier VI	16 H.	A.	89×89	8.830	.390	7	355/370	3,650	4,750	380/395	4,000	6,000	365	713
Dagger III	24 H.	A.	97×95	16.8	.371	7.75	700/725	3,500	3,500	780/805	4,000	5,000	760	1,305
Dagger VIII	24 H.	A.	97×95	16.8	.308	7.5	925	4,000	9,000	1,000	4,200	8,750	955	1,300
ROLLS-ROYCE														
Kestrel XXX	12 V.	W.	127×140	21.3	—	—	550	2,400	11,750	600	2,750	14,250	720	967
Merlin II, III	12 V.	E.G.	137.2×152.4	27	.477-	6	900	2,600	12,250	1,030	3,000	16,250	890	1,335
Merlin X	12 V.	E.G.	137.2×152.4	27	.477	—	1,040 / 965	2,600	2,500 / 13,250 2-S.	1,145 / 1,025	3,000	5,250 / 17,750	1,065	1,394

A. = Air. W. = Water. C.W. = Composite water. E.G. = Ethylene Glycol. R. = Radial. 2-R. = Two-row Radial. H. = "H" formation. V. = "V" formation. L. = In Line. I. = Inverted. H.O. = Horizontally opposed. D. = Direct Drive. S.L. = Sea Level. 2-S. = Two-speed Supercharger.

* Readers will no doubt have realised that the war requirements prevent the publication of technical data on the new types of aero engines which have been developed since the outbreak of hostilities.

As defined in the Air Ministry Airworthiness Handbook for Civil Aircraft (A.P. 1208), international rated power is the brake horse power developed in a test when the engine is running at "international r.p.m." under the standard atmospheric conditions of the rated altitude "International r.p.m." is the maximum crankshaft speed at which the engine may be run for long periods, as declared by the maker. Rated altitude is the lowest altitude at which full-throttle running is permissible or, for supercharged engines, the highest altitude at which the rated boost pressure can be maintained when running at "international r.p.m."

Maximum level flight r.p.m. is the maximum safe crankshaft speed at which the engine may run for short periods (for example, 5 minutes) as declared by the maker.

All tests are to be made at 90 per cent. of the international power and at international r.p.m. All engines must, however, be opened out to full throttle at international r.p.m. for the last 5 minutes of all test runs. All engines subsequent to the one which is type-tested must develop not less than 95 per cent. of the international power.

HOW MANY FIRMS MAKE AN AEROPLANE?

Co-ordination in Manufacture : Effect of Flight on Scientific and Industrial Invention : Meaning of "Aircraft Quality"

By BRUCE FOSTER

In previous years it has been the custom of Flight *to include in this annual number a review of the work and products of all firms supplying aircraft components and materials. To-day, so many new firms have been added to the already long list of those which formerly made up the Aircraft Industry that a comprehensive list of them, even without addresses, would be a directory not without value to the enemy. So in conformity with official desires, we have this year refrained from including such a list, but this will again form a feature of the issue in happier times. Here is a contribution which indicates the almost endless variety of products required for the manufacture of modern aircraft and how the branches of the industry extend into almost every manufacturing activity.*

THIS article is not a variation of "How many beans make five?" but it started life as an attempt to satisfy those statistically queer minds which love to be told that if all the digging for victory by the allotment holders on Saturday afternoon were done on the same spot, the hole would be so deep that it would reach to the centre of the earth and half-way back again and so provide a deep shelter, proof against the impact of anything except a comet (which, of course, would make us safe from aerial attack and be a Good Thing).

The article was going to tell those people who want to know just how many different firms are concerned in the production of an aeroplane. (It was hoped to tell them something as exact as 439, but this was not the final answer which came out.)

The aeroplane is not only a masterpiece of design, but also a marvel of co-ordination. The people who design it must know a lot about some things and a little about everything, for a moment's thought shows that contributions to its structure and its engine come from near and far, and the designer must give to each fabricated part and piece of material its allotted function to fulfil.

"Animal, vegetable or mineral?" says the old game. What answer would you give for an aeroplane?

With all its metal, it is certainly predominantly "mineral," but if it is a wooden one, it has plenty of "vegetable" about it in its wooden structure and linen fabric of flax. And the "animal" is not absent either—its casein or blood albumin glue and the intestinal lining of the flexible petrol tubing are examples.

Variety of Materials

Its materials are of most diverse nature and come from parts of the globe which are equally diverse. Rubber from the East, wood from America or Scandinavia, and the metals, steel, aluminium, magnesium and the alloy constituents, from various parts of the world. It is a solemn thought that, without international commerce, war could not be fought with the aeroplane, for it could not be built; control of the alloy constituents for steel, for example, means complete control of war-making powers.

The buying department of an aircraft firm is the place in which to come to full realisation of the enormous number of firms which supply materials, small parts, and finished assemblies.

The finished assembly is a well-established product now, having appeared during the last ten years. Undercarriages are a noteworthy example, being supplied ready to attach to the airframe.

The small parts, of which the A.G.S. make up a large proportion, are made in this country by numerous firms. Bolts, nuts, taper pins, shackles, fork ends, tube end sockets, turn-buckles, screws, split pins, fasteners—all these and numerous others make up a list of tremendous length. They all make their contribution to the airframe or engine. And they are all important, even the humble split pin.

The failure (or was it the omission?) of a split pin in the throttle linkage once ruined a non-stop flight from England to India which had been commenced after months of planning which extended half-way round the world. It was Sir Alan Cobham's Airspeed Courier which was to make this long flight by refuelling in the air. But the throttle linkage became disconnected, and the butterfly valve shut and stopped the engine; there was nothing for it but to make a forced landing. Luckily, Malta was underneath, and the Courier was landed wheels up without injury to Sir Alan. Death was narrowly missed, but thousands of pounds had been wasted just because of a split pin.

As for the materials which the buying department obtains, these are covered by the appropriate British Standard or D.T.D. specification—and it is a perpetually recurring cry that the number always seems to increase and never to decrease. Probably on any one aeroplane one could find an example of each of the main classes of materials—the steels, aluminium alloys, magnesium alloys, the brasses and bronzes. One might even find an example of each of the different forms in which material may be—drawn tubing, extrusion, rolled strip, flat sheet, solid bar, casting or forging. And if an example of each is found, the chances are that each one will have come from a different firm, such is the degree of specialisation to-day.

Then we are carried farther as soon as we think of some of the other parts—the windscreen is a synthetic resinoid, or more popularly a "plastic," moulded to its streamlined shape by some firm which has made a study of this work. This firm probably has not made the sheet material, but has obtained it from a chemical manufacturing firm making all types of resinoids just as one of its many lines.

Landing lights, too, are a product involving in themselves the co-ordinated efforts of several firms. The reflector, the globe, the solenoid by which the direction of the lamp or its refraction is controlled; all are different units assembled by one firm and involving the products of several others. Then the finished lamp is sent on to the aircraft factory.

If one takes some particular part of an aeroplane and seeks to trace out the chain of firms which contribute to its making, one could go a long way. Take, for instance, the design office. There the aeroplane is thought out and wrought to shape on paper, after much mental work and worry—and swearing, when the Chief Designer says the span must be increased by five feet. But without all the drawing office supplies the mental work could not be done. Tracing paper, pencils, T-squares, drafting machines, rubbers, drawing instruments, all play their part, and the print-making machinery and sensitive blue-print paper must not be forgotten. And if one looked into the question of how all these products were made, another vista would be opened up. But that is becoming too wide.

The Effect on Other Sciences

Flight was made possible by advances in other sciences. It was impossible to get off the ground until metallurgy had produced metals out of which an engine comparatively light in relation to its power could be made. Aeronautics now has become sufficiently advanced to have an effect in return on those sciences which made it possible.

Its impact on metallurgy has been extremely powerful, and its demands have stimulated that science to tremendously successful efforts in all metals. Though duralumin was invented such a long time ago that it cannot be said to be due to an aeronautical demand, it undoubtedly owes

HOW MANY FIRMS MAKE AN AEROPLANE? (CONTINUED)

its enormous development to flying. The Alclad type of light alloy sheet is a triumph of the metallurgical firms and is made by rolling out a "sandwich" billet of aluminium and duralumin in which the duralumin is a very thick piece of meat and the aluminium slabs are the bread. The rolling bonds them together.

Practically every branch of the metal industry has a product used in aircraft: steels, brasses, bronzes, babbits and other bearing metals. It is in these last, the bearing metals, that developments have been made through the persistence of aero-engine designers in asking the metallurgists for metals which will stand higher and ever higher loads per square inch. So the cadmium-silver alloy, which is over 98 per cent. cadmium, with nearly one per cent. silver and a little copper, was developed. A tin base babbit can be used up to a pressure of 1,000 lb./sq. in., but the cadmium-silver will stand pressures between 1,800 and 3,800 lb./sq. in.

The modern valve steel, too, is the result of a "ridiculous" demand by the engine designer for a steel which would stand up to a terrific hammering, gaseous flow of eroding velocity, and a temperature of practically a dull red heat, without losing its physical properties.

Aircraft Quality

A catchword sometimes used is to describe a product as of "aircraft quality" or "aircraft type." It is interesting to speculate on just what this can mean.

Aeronautics usually demands of its products that they have all or some of the following characteristics:

1. Low weight.
2. Low aerodynamic drag.
3. Great reliability.
4. High speed.

Low weight needs little comment. Nothing on the airframe or engine escapes the investigation for surplus weight—there is a ruthless search for it. Weight must be reduced by more efficient design or by using a more suitable material. Rubber has been developed in the "blown up" form to make it lighter while retaining its desirable elastic properties. All sorts of other lightweight products have been developed.

Low aerodynamic drag refers only to components on the outside of the aeroplane, and the streamlined landing wheel tyre for fixed undercarriages is an example of this.

Great reliability was called for in aircraft because of the serious nature of the penalty for failure. To return to the ground when you have no intention of so doing can be both serious and spectacular, and for that reason every possible attempt is made to eliminate doubt about the strength of any part. X-ray equipment plays an important role in the certification of castings. This originally medical technique now has a very great aeronautical application and castings are X-rayed for cracks and blow-holes with specially adapted plant.

In mentioning speed, it was not forward speed which was intended, but speed of a process. Refuelling equipment for aircraft had to be specially developed because of the great quantities of fuel which have to be pumped into a fighter in a short time—this is one example of the speed which aviation insists upon. Navigation, too, existed as an exact science long before flight had been accomplished, but it remained for flight to "speed it up." Because of the 200 and 300 m.p.h. of aircraft it became necessary to work out the position very speedily after an astronomical sight had been taken, or otherwise it was of no value and only told where you had been and not where you were. So position line slide rules and quick-reference star tables have been developed to satisfy aviation's thirst for speed.

Aeronautical Inventiveness

The flood of inventions which the accomplishment of flight has let loose upon the world is something at which to marvel. Until the aeroplane demanded a screwed joint which would lock and which did not need access to both sides, we did not have the various shake-proof screws and the elastic stop nut, a nut which is now used in its millions on aircraft.

The frequent difficulty of access to both sides when riveting has brought forth a wonderful array of ingenious rivet types. The pop rivet which is "headed over" by either breaking the head off a mandrel or by pulling a mandrel through and so expanding the rivet is very familiar. The Chobert rivet and its "gun" is another "one-sided" rivet development. Then the De Bergue, too, is an aircraft rivet developed for petrol tanks.

The ordinary cup rivet was developed because the shear strength of a solid one was unnecessarily high in relation to its bearing strength in thin metal. Then to cover the open end the cap was added and we had the "cap-cup" rivet. Latest addition to the list of rivet designs is the Linread tubular rivet made out of sheet.

Some time soon the explosive rivet will be with us, for the Du Pont interests in U.S.A. are developing this latest example of inventiveness.

Thread-cutting screws are another most ingenious development brought forth by the sheet metal work on aircraft. They can be screwed into multiple thicknesses of sheet metal and hold much as a wood screw does. But though each one of these examples of man's ingenuity has been an answer to some demand of the insatiable flying machine, they will all affect others of man's productions, such as his motor cars, boats, and domestic hardware.

The various parts used in aircraft are very numerous; leather on the seats is just one of them. But if we follow this back we come to the tanner and, finally, the farm on which the animal was reared. And as for the parachute, that takes us back through the silk weavers to the spinners and so to the silk-worm farm—so how many firms make an aeroplane?

LISBON TO ENGLAND BY AIR

A CABLE sent to U.S.A. recently dealt with the flight from Lisbon to this country of three American journalists on the staff of the Associated Press. We think our readers will be interested to read this, or try to, in "cablese."

"Seaflight over German patrolled waters off western coast of france from lisbon to london so uneventful passengers slept most of nine-hour daylight trip.

"APstaffers humphreys incgaffin eye* arrived quote somewhere england unq' ote last night. Most amazing thing about this air link between england and continent is normal way service runs. Cocky english steward serves morning coffee soons plane leaves ground.

"Lunch is five course meal including hot soup and meats while sharply around 1600 comes traditional british tea tray. Passengers are booked lisbon in office in same building where german hamburgamerica line has offices. There nothing hush-hush about it all. Theoretically anyone able reserve passage.

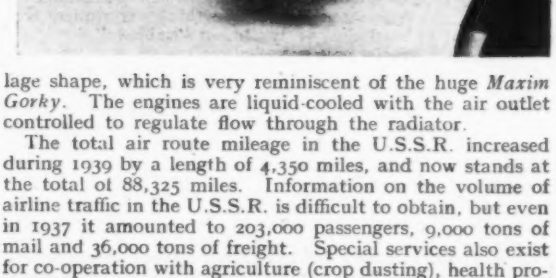
"It only on takeoff and in air that unusual flying precautions taken by airline in cooperation airministry. General setup even these known lisbon freely talked about as example way wartime britain carrying on. Since plane never takes same route twice there no danger telling general terms how service works. Passengers are telephoned previous afternoon told what time report airport which same used by pan-american clippers. At airport they clear customs then wait until word comes through that it safe try to get through.

"It only after english coast sighted that nervous tension felt aboard plane. Then pilot constantly changes altitude hunting friendly banks in which hide. Because englands traditional bad weather that not difficult. Once we flew less hundred feet above calm channel waters. Flyingboats are unarmoured carry no armament since british government lists them as non-combatant ships. At airport somewhere in england landing carried out passengers docked just as in peacetime. Only difference in unusual numbers men women uniform soldiers. end."

(* "Humphreys, McGaffin and I of the Associated Press Staff.")

RUSSIAN AIRLINER L-760

Six Engines : Fixed Undercarriage : Wing Cabins : Low Speed



The Soviet L-760 is a big airliner, so big that it has sleeping cabins in the wings for some of its 64 passengers. The small "look-out" on the top surface is part of the wing compartment.

THIS Soviet passenger airliner, the L-760, has a wing span of 210ft. and a total loaded weight of 103,000lb. (46 tons). Its five cabins in the fuselage and four sleeping compartments can accommodate 64 passengers; the crew is ten. A maximum speed of 186 m.p.h. is claimed for it and it cruises at 130 Cruising range is given as 1,864 miles, and ceiling 23,000ft. The six engines deliver 8,000 h.p.

The L-760 was put on to the run from Moscow to the Caucasus last June and covered the 965-mile route at an average speed of 125 m.p.h. This is not fast according to modern ideas, and one does not have to look far for the reasons. The fixed undercarriage is one of them and the large wing (and therefore low wing loading) is another. In comparing it with the Douglas B-19, it is evident that the wing is about the same size (both have spans of 210ft.), whereas the weight of the Douglas is about 50 per cent. greater. The powers of the two craft are about the same.

Another reason for low speed is the rather ungainly fuselage shape, which is very reminiscent of the huge *Maxim Gorky*. The engines are liquid-cooled with the air outlet controlled to regulate flow through the radiator.

The total air route mileage in the U.S.S.R. increased during 1939 by a length of 4,350 miles, and now stands at the total of 88,325 miles. Information on the volume of airline traffic in the U.S.S.R. is difficult to obtain, but even in 1937 it amounted to 203,000 passengers, 9,000 tons of mail and 36,000 tons of freight. Special services also exist for co-operation with agriculture (crop dusting), health protection (anti-malarial applications), and forestry and fisheries.

SERVICE AVIATION

Royal Air Force and Fleet Air Arm News and Announcements

STRIPPED FOR ACTION: Hurricane pilots of the Western Desert find it hot work.

Serving in the United Kingdom

DIFFICULTY has been experienced by R.A.F. personnel, and Dominion personnel serving with R.A.F. units, in receiving private correspondence addressed to them by friends and relatives overseas. Officers and airmen should note that no difficulty will arise if the R.A.F. station at which they are serving is given as their address for postal purposes, provided no mention is made of the R.A.F. unit in which they are serving. Where correspondents overseas are not aware of the address of the R.A.F. station at which personnel are serving in a R.A.F. unit, correspondence may be addressed as follows:—

Officers: C/o Air Ministry (S.7.B.), Adastral House, Kingsway, London, W.C.2.

Airmen: C/o Air Officer-in-Charge of Records, Royal Air Force Record Office, Ruislip, Middlesex.

The New Zealand and Southern Rhodesian authorities prefer that the existing arrangements, whereby letters are addressed care of the appropriate High Commissioner in London, should continue, and this order is therefore not intended to alter the existing arrangements in respect of New Zealanders and Rhodesians.

It is important that letters and parcels so addressed should give the number, rank and name of the officer or airman in order that they may be correctly readdressed without delay.

Empire Air Training

THE first contingent of airmen trained in Canada under the Empire Air Training Scheme has arrived at a port in the North-West of England. They were welcomed by Air Vice-Marshal C. W. H. Pulford, representing the R.A.F. and by Air Commodore L. F. Stevenson, Royal Canadian Air Force Liaison Officer in this country.

The entire contingent, comprising pilot officers and sergeants, are air observers and they will shortly be posted for active service in the R.A.F. All these men are Canadians, but under the Empire Air Training Scheme a large number of Australians and New Zealanders and men from the United Kingdom, are undergoing advanced training in Canada as pilots and wireless-operator air gunners as well as air observers.

Other pilots and air crews are being wholly trained in Australia and New Zealand. Some of these have already arrived in this country and others will go direct to Air Force bases overseas.

From now onwards pilots, observers and air gunners trained in the different parts of the British Commonwealth overseas will be arriving in this country at frequent intervals and in ever increasing numbers.

Awards

THE King has been graciously pleased to approve the following awards, in recognition of gallantry displayed in flying operations against the enemy:—

DISTINGUISHED SERVICE ORDER.

P/O. G. L. CHESHIRE, No. 102 SQN.

DISTINGUISHED FLYING MEDAL.

Sgt. H. DAVIDSON, No. 102 SQN.

P/O. Cheshire and Sgt. Davidson were the captain and wireless operator respectively in an aircraft detailed to attack a target near Cologne one night in November, 1940. During a lull, following half an hour's intense and accurate anti-aircraft fire, a photographic flare was about to be dropped from a height of 8,000 feet, when it was detonated by a piece of shrapnel causing a blinding explosion in the fuselage and front turret. The cockpit was filled with black fumes and fire broke out. Sgt. Davidson was dazed by the explosion, his face and hands were badly burned and his clothing was set on fire.

Showing great coolness P/O. Cheshire regained control of his aircraft, which had lost considerable height and was being subjected to intense anti-aircraft fire, and although the explosion had blown out a considerable part of the fuselage and caused other damage, he finally succeeded in regaining height. When the fire was extinguished, Sgt. Davidson's injuries were so severe that he was unable to see. In spite of this he persuaded the rear gunner to guide his burned fingers to the wireless controls as he called out the settings, a process which was continued until it was realised the wireless was useless.

Despite his intense suffering Sgt. Davidson displayed great courage and fortitude by consistently refusing to be landed at a station nearer than base. Although the aircraft was only partially answering to controls, P/O. Cheshire succeeded in regaining his aerodrome. He displayed great courage, determination and leadership throughout.

BAR TO THE DISTINGUISHED FLYING CROSS.

ACT. FLT. LT. J. W. VILLA, D.F.C., No. 92 SQN.—In October, 1940, this officer led his squadron in an attack against an enemy bombing formation attempting a raid on London, and immediately caused the enemy to jettison their bombs and form a defensive circle. He pressed home his attack with great determination and assisted in the destruction of two Messerschmitt 109's and possibly a further two. He has shown outstanding powers of leadership, skill and courage and has destroyed a total of thirteen hostile aircraft.

P/O. T. F. NEIL, D.F.C., No. 249 SQN.—In November, 1940, this officer engaged a Junkers 87 which he destroyed within the space of six minutes. He was then attacked by three Messerschmitt 109's, two of which he destroyed. His magnificent fighting spirit has enabled him to destroy at least eleven enemy aircraft.

DISTINGUISHED FLYING CROSS.

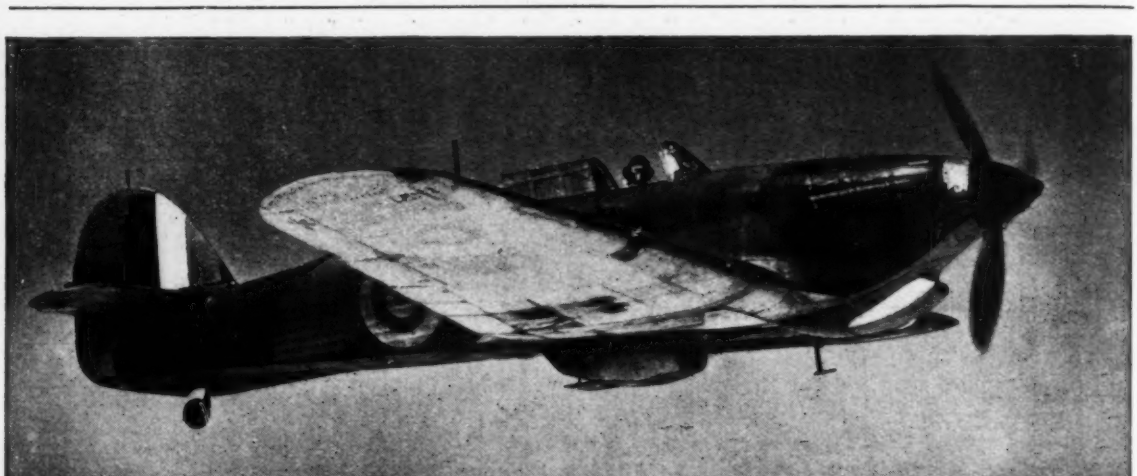
FLT. LT. H. N. BLATCHFORD, No. 257 SQN.—In November, 1940, this officer was the leader of a squadron which destroyed eight and damaged a further five enemy aircraft in one day. In the course of the combat he rammed and damaged a hostile fighter when his ammunition was expended, and then made two determined head-on feint attacks on enemy fighters, which drove them off. He has shown magnificent leadership and outstanding courage.

FLT. LT. J. C. BOULTER, No. 603 SQN.—This officer has continuously been engaged on active operations since October, 1940. He is an excellent and determined leader, and his coolness and initiative have enabled him to destroy at least five enemy aircraft and share in the destruction of others.

FLT. LT. W. B. GODDARD, No. 235 SQN.—In November, 1940, this officer was engaged in

WITH FELLOW PILOTS: H.M. The King inspecting photographs during a visit to a Bomber station briefing room.

SERVICE AVIATION (CONTINUED)



MIDDLE EAST FIGHTER: After covering itself with glory in the Battles of France and England, the Hurricane is becoming the terror of the *Regia Aeronautica* in north east Africa and Greece. Note the Vokes aircleaner in front of the intake to keep sand from entering the engine.

an attack against two Heinkel 115's. Although severely wounded in the foot, resulting in the loss of three toes, Flt. Lt. Goddard pressed home his attack to within close range and succeeded in delivering a long burst, after which the enemy aircraft disappeared. Despite suffering from loss of blood, he succeeded in bringing his aircraft and crew back to base. He displayed gallantry and fortitude throughout.

SQN. LDR. J. MCDOUGALL, No. 110 SQN.—One night in November, 1940, Sqn. Ldr. McDougall was the pilot and Sgt. Gray the air gunner of an aircraft detailed to carry out harassing attacks on enemy aerodromes. At 0300 hours Amiens-Glisy aerodrome was identified and found to be illuminated for night flying. A large four-engined enemy aircraft was seen in the air, and Sqn. Ldr. McDougall decided to attack it before bombing the aerodrome. He rapidly overhauled the enemy, and from close range Sgt. Gray opened fire. His first burst entered one of the port engines which immediately emitted smoke. He then fired two long bursts into the fuselage. The aircraft was seen to fall, out of control, and eventually it hit the ground and exploded. Sqn. Ldr. McDougall then returned to Amiens-Glisy and bombed the aerodrome in the face of intense and accurate anti-aircraft fire. He has completed 22 and Sgt. Gray 26 operational missions, and both have at all times pressed home their attacks with courage and determination.

FLT. LT. P. G. WYKEHAM-BARNES, No. 274 SQN.—This officer was the first pilot of his squadron to engage the enemy. In a combat with 12 enemy fighters he shot down two and has since destroyed at least five, and shared in the destruction of one other. On one occasion he was himself shot down and forced to return on foot to his base. Flt. Lt. Wykeham-Barnes has displayed dauntless leadership and the finest fighting spirit.

F/O. G. E. P. GREEN, No. 55 SQN.—In October 1940, F/O. Green, although wounded and with the hydraulic gun control and instrument board out of action, successfully bombed the enemy concentration of aircraft at El Adem and, regardless of prolonged attacks by enemy fighters, brought his aircraft and crew safely home.

ACT. F/O. G. F. REID, No. 49 SQN.—In November, 1940, F/O. Reid was the navigator of an aircraft detailed to attack military objectives in Dantzig and to scatter leaflets in Poland. By his skilful and accurate navigation he contributed largely to the success of the operation, which was completed in ten and a half hours in spite of extremely difficult conditions. F/O. Reid has completed 32 operational flights over enemy and enemy occupied territory, and his work has been of the greatest assistance to his pilots. He has shown outstanding skill, courage and devotion to duty.

LT. E. G. ARMSTRONG, No. 11 SQN., SOUTH AFRICAN AIR FORCE.—In August and September, 1940, regardless of attacks by enemy fighters, Lt. Armstrong, with conspicuous gallantry and devotion to duty, obtained photographs of strategical value in the Mogadishu area. The photographs were instrumental in locating important targets, which were later demolished by his squadron.

P/O. R. O. BUSKELL, R.A.F.V.R., No. 18 SQN.—One night in November, 1940, P/O. Buskell was the pilot of an aircraft detailed to attack Melun aerodrome. After patrolling the neighbourhood for 45 minutes he located his target and immediately delivered a low level attack from 2,500 feet. The first two 250 lb. bombs were seen to hit the hangars, while the third scored a direct hit and destroyed an aircraft on the ground. In spite of intense and accurate light anti-aircraft fire which hit the aircraft in several places and rendered the port aileron useless, P/O. Buskell delivered a second attack from a height of only 800 feet, scoring direct hits on the hangars with his remaining bombs. He displayed great courage and determination in pressing home his attack at a low altitude.

ACT. SQN. LDR. N. M. BOFFEE, No. 75 (NEW ZEALAND) SQN.—One night in November, 1940, this officer was captain of an aircraft detailed to attack the railway yards at Munich. He was the first to locate the target, which he successfully bombed, causing large fires that were instrumental in guiding subsequent aircraft to the area. The successful completion of the operation was largely due to Sqn. Ldr. Boffee's accuracy in navigation and bomb-aiming. His work as a flight commander has been marked by consistent keenness and devotion to duty and, as captain of aircraft, he has taken part in twenty-seven bombing attacks.

ACT. FLT. LT. A. W. A. BAYNE, No. 17 SQN.—In November, 1940, this officer led his squadron against twenty-five heavily escorted enemy dive bombers which were attacking two destroyers. His magnificent leadership and quick judgment largely contributed to the splendid success of the squadron which destroyed fifteen and damaged several more of the enemy bombers without loss. He has himself destroyed four enemy aircraft and assisted in the destruction of others.

ACT. FLT. LT. L. W. COLEMAN, R.A.F.V.R., No. 149 SQN.—In November, 1940, this officer was captain of an aircraft detailed to attack the railway yards and locomotive sheds at Munich. In spite of the fact that on his arrival he found considerable anti-aircraft activity and that he had been warned of the presence of balloons, he glided down to a height of 3,500 feet and straddled the target with his bombs. He then circled the town and ordered his air gunners to put out as many searchlights as possible. Since June, 1940, Flt. Lt. Coleman has carried out twenty-five raids, fifteen of them as captain of aircraft, during which he has displayed skill, persistent determination and devotion to duty and has set a magnificent example to his squadron.

ACT. FLT. LT. W. J. LAWSON, No. 19 SQN.—Flt. Lt. Lawson has consistently led his flight, and frequently his squadron, with great skill and courage, and has destroyed at least five enemy aircraft. His exceptional coolness inspires great confidence in his fellow pilots. On two occasions he has refused to abandon his aircraft when damage caused would clearly have justified such a course.

F/O. R. G. A. BARCLAY, R.A.F.V.R., No. 249 SQN.—This officer has shown admirable coolness and courage in combat against the enemy. His keenness and determination have enabled him to destroy at least four of their aircraft.

P/O. G. E. GOODMAN, No. 1 SQN.—This officer has performed outstanding work in all his engagements against the enemy. In October, 1940, he assisted in the destruction of an enemy bomber which was attacking an aerodrome in the failing light at dusk. His courage and resourcefulness have enabled him to destroy at least six enemy aircraft.

P/O. D. C. LEARY, No. 17 SQN.—In November, 1940, this officer was engaged with his squadron in protecting two destroyers which were being attacked by a formation of enemy dive bombers heavily escorted by fighters. Showing magnificent courage and determination P/O. Leary destroyed two of the enemy bombers and assisted in the destruction of another. He has now destroyed at least five enemy aircraft.

ACT. FLT. LT. R. SAWREY-COOKSON, No. 149 (B) SQN.—One night in November, 1940, this officer was detailed to attack a target at Gelsenkirchen. He was unable to locate his target owing to heavy cloud, but, determined to find a profitable objective, he eventually located an unlighted aerodrome on which nine large bombers were lined up on the runway.

Diving to 1,500 feet he made several runs over the aerodromes, and, in spite of opposition from ground defences, dropped his bombs when sure of obtaining good results. He has consistently shown the utmost determination in locating and accurately bombing his target.

Flight Lieutenant Sawrey-Cookson has completed many operational flights over enemy and enemy-occupied territory.

WING CDR. G. FRANCIS, No. 230 SQN.
MAJOR C. E. MARTIN, No. 12 SQN., SOUTH AFRICAN AIR FORCE.

FLT. LT. J. H. LAPSLEY, No. 274 SQN.
P/O. F. H. MARTIN, R.A.F.V.R., No. 8 SQN.

AWARDED THE DISTINGUISHED FLYING MEDAL.

SGT. W. H. TAMLIN, No. 8 SQN.

The recipient of one of the above awards destroyed six enemy aircraft and probably one more in two months. On one occasion he attacked single-handed a formation of four enemy aircraft and destroyed three. Another has taken part in 25 raids in Abyssinia and Italian Somaliland in which 11 enemy aircraft have been brought down.

Another recipient has carried out many long distance reconnaissances close to enemy coasts. On one occasion he disregarded an attack by enemy fighters on the flying boat of which he was captain and continued a reconnaissance for seven hours, giving invaluable directions to the fleet which resulted in the sinking of an enemy ship.

BAR TO THE DISTINGUISHED FLYING MEDAL.

FLT. SGT. G. C. UNWIN, D.F.M., No. 19 SQN.—This airman has shown the greatest keenness, courage and determination to engage the enemy. He is an outstanding fighter pilot and has destroyed a total of thirteen enemy aircraft and assisted in the destruction of others.

DISTINGUISHED FLYING MEDAL.

SGT. D. E. KINGABY, No. 92 SQN.—This airman has displayed great courage and tenacity in his attacks against the enemy. He has destroyed at least nine hostile aircraft, four of which he shot down in one day.

Sgt. M. C. B. BODDINGTON, R.A.F.V.R., No. 234 SQN.—This airman has participated in nearly every operation patrol carried out by his squadron. He has displayed great determination, coolness and courage and has destroyed six hostile aircraft.

SGT. E. W. WRIGHT, R.A.F.V.R., No. 605 SQN.—This airman has displayed fine qualities of leadership, skill and courage. His sound tactics and efficiency have enabled him to destroy at least six enemy aircraft.

SGT. G. GRIFFITHS, No. 17 SQN.—This airman has shown splendid courage and initiative in his attacks against the enemy. He has destroyed at least six of their aircraft, two of which were shot down in one day.

SGT. G. E. PRICE, R.A.F.V.R., No. 49 SQN.—

SERVICE AVIATION (CONTINUED)

In November, 1940, this airman was captain of an aircraft detailed to attack military objectives in Dantzig and to drop leaflets in Poland. In spite of hazardous conditions involving long periods of instrument flying, he completed his tasks successfully and returned to base after ten and a half hours' flying. A few nights earlier, he carried out a successful attack on Kiel in extremely dangerous flying conditions. In all his operational missions Sgt. Price has shown outstanding skill, courage and devotion to duty.

AIR CPL. P. C. SEWELL, No. 11 B. SQN., SOUTH AFRICAN AIR FORCE.—Cpl. Sewell has displayed continuous gallantry and devotion to duty while photographing points of immense military and strategical value in the Mogadishu area in August and September, 1940.

SGT. C. H. GRAY, No. 110 SQN.—(See Sqn. Ldr. J. McDougall.)

Prisoners of War

NEXT of kin, if able to identify the men from the information published, are requested to advise the Casualty Branches of the Services concerned, forwarding Regimental or any other details.

The following is the latest list of British prisoners of war as received from enemy sources:—

In German hands:—Sgt. J. Daniels, Great Lister Street, Birmingham; Sgt. R. L. Hollidge, Coombe Road, New Malden; P/O. D. A. Young, Turnpike Bucks Green, Chelmsford; Sgt. Johnson, The Gallio, Little Barn Lane, Mansfield; Sgt. J. I. Boyle, 12, Manor Road, Blackburn; Sgt. H. Booth, Lyne Terrace, Lynmouth, Northumberland; Sgt. F. M. Carr, The Old Vicarage, Lewknor, Oxfordshire; Sgt. P. J. Sharpe, Grey Stoke, Park Walk, Rugby; P/O. R. S. Jesmond, Uttoxeter Road, Derby; Sgt. H. Newall, Junction Lane, Lathom, Lancs; P/O. R. V. Darbyshire, Boot Inn, Stanford, Dingley, Berks, and Mill Street, Manchester; Sgt. R. F. Ackerman, Wye-by-Ashford, Kent; P/O. A. W. P. Thomas, Ashbrook, Offerton Lane, Stockport; Sgt. A. Hunt, Langworthy Road, South Salford, Lancs; Sqn. Ldr. S. G. Pritchard, 6, Hatcher (? Thatcher) Street, Bury St. Edmunds, Suffolk; P/O. Barolet (?), Old Farmstead, Loudwater, by Rickmansworth, Herts.

Casualty Corrections

Casualty Communique No. 53.

Reported "Missing," now reported "prisoner of war." Delete the undermentioned:—Sgt. S. A. Eley, 564041; P/O. B. K. L. Fuge, 41394; P/O. J. C. Mallon, 42719.

London Gazette

Royal Air Force

General Duties Branch.

The undermentioned Flight Lieutenants (temporary Squadron Leaders) are granted permanent commissions in the substantive rank of Flight Lieutenant:—(Mar. 15) R. C. Crawford; (Sept. 14) B. Samson.

The undermentioned are granted commissions for the duration of hostilities as Pilot Officers on probation:—Flight Sergeants:—(Oct. 26, Sen. Oct. 16) E. E. Fitchew; (Nov. 5, Sen. Oct. 30) D. T. Witt; (Nov. 14, Sen. Nov. 6) C. Midwinter; (Nov. 15, Sen. Nov. 6) E. J. Fleet; (Nov. 16, Sen. Nov. 6) A. E. Feather; Sergeants:—(Aug. 13, Sen. Aug. 9) R. J. Jones; (Aug. 20, Sen. Aug. 9) J. P. Balfour; (Aug. 24, Sen. Aug. 7) R. S. Gunning, D.F.M.; (Sept. 7, Sen. Aug. 28) G. B. Blacklock; (Oct. 15, Sen. Oct. 9) A. M. Crouch; (Oct. 26, Sen. Oct. 16) A. D. Bentley; (Nov. 1, Sen. Oct. 16) E. H. Abbott; (Nov. 2, Sen. Oct. 9) A. E. Forgeard; (Nov. 6, Sen. Oct. 30) C. N. S. Campbell, R. C. G. Harman, H. G. Jones, L. H. Styles; (Nov. 7, Sen. Oct. 30) W. E. G. West.

The undermentioned Pilot Officers on probation are confirmed in their appointments:—(Oct. 1) C. Warren; (Oct. 8) T. R. Burne; (Oct. 9) E. M. C. Guest, J. C. Lowe, T. P. Seymour; (Oct. 23) R. H. Holland, A. R. Wright, D.F.C., R. D. Yule.

The undermentioned Pilot Officers on probation are confirmed in their appointments and promoted to the rank of Flying Officer:—(Sept. 28, Sen. Sept. 27) G. Ashfield; (Oct. 1) J. D. Steuart-Richardson; (Oct. 8) J. C. Alexander, R. J. S. Parsons; (Oct. 9) M. C. Raban; (Nov. 26, Sen. Sept. 27) J. Mitchell.

The undermentioned Flying Officers are promoted to the rank of Flight Lieutenant:—(Sept. 3) J. T. Gibson (ret.), M. H. Cox, C. H. Boxall; (Sept. 13, Sen. Sept. 13, 1939) A. D. Bryant (Capt. R. Northumberland Fusiliers), P. Legge (Capt. R.A.); (Sept. 22, Sen. Sept. 22, 1939) W. D. Blackwood, D.F.C. (Lt. R. Tank Corps); (Oct. 1) J. A. F. Maclachlan, D.F.C., G. L. Sinclair, D.F.C., J. L. Riley, P. R. O'Connor; (Oct. 4) G. Wilson (ret.), A. T. Staveley; (Oct. 5) M. K. Carswell; (Oct. 8) J. R. Barnley; (Oct. 9) A. M. Campbell; (Oct. 15) K. H. Blair, D.F.C., H. N. Burrows, W. D. L. Filson-Young; (Oct. 26) J. W. Villa, D.F.C.; (Nov. 1) F. Austin; (Nov. 24) J. H. G. Walker; (Nov. 30) J. F. Sharp.

The undermentioned Pilot Officers are promoted to the rank of Flying Officer:—(Mar. 6) J. R. Whelan, D.F.C.; (Apr. 7, Sen. Jan. 7) P. H. Baldwin, K. D. Bruce, G. L. Cheshire, B. A. Rogers, A. C. L. Akroyd-Stuart, R. W. Whittome; (Apr. 21, Sen. July 21, 1939) P. J. Carpenter, R. W. H. Stevenson, R. Gray; (June 5) D. G. Heaton-Nicholls; (Sept. 3) D. R. Turley-George, C. M. B. Symons; (Sept. 23) L. W. Stevens, V. G. W. Engstrom; (Sept. 30) L. M. O'Leary; (Oct. 2) L. E. Cryderman, W. H. Arnold, L. C. Kingsbury; J. A. Dixon, (Oct. 3) A. S. Lanney; (Oct. 23) W. Armstrong; (Nov. 6) R. M. Trousdale, R. H. Wiens, W. L. McKnight, D.F.C., M. B. Mallet, F. G. Axtell, R. W. Stokes, M. H. Young, D. H. S. Kay, D.F.C., S. R. Thomas; (Nov 18) T. D. Saul.

The undermentioned Squadron Leaders are transferred to the Technical Branch (Apr. 24):—R. R. Fairweather, F. W. Foster, D.F.C., D.S.M.

P/O. L. F. Humphrey is seconded for special duty. (July 1.)

F/O. G. H. F. Plinston takes rank and precedence as if his appointment as Flying Officer bore date Oct. 26, 1938. Reluction to take effect from Oct. 8.

Group Capt. E. D. M. Robertson, C.B., D.F.C. (ret.), reverts to the retired list and resumes his former rank of Air Commodore, in which rank he is recalled to the active list. (Nov. 21.)

The undermentioned Pilot Officers relinquish their temporary commissions on return to Army duty:—(Oct. 25) R. B. O'H. Warburton, 2nd Lt., R.E. (T.A.); (Nov. 2) M. L. Marsh, 2nd Lt., R. Warwick R. (T.A.).

The undermentioned relinquish their short service commissions on account of ill-health:—(Nov. 26) F/O. J. A. H. Beckton; (Dec. 3) P/O. J. F. Howitt.

Erratum.

Notification of July 16 concerning Flt. Sgt. G. P. Hall should have appeared under the heading R.A.F., and not R.A.F.V.R.

Technical Branch.

The undermentioned are granted commissions for the duration of hostilities:—Flying Officers on probation. Warrant Officers:—(Nov. 1, Sen. Oct. 22) W. A. Dawe; (Nov. 5, Sen. Oct. 25) E. H. Sillince; (Nov. 7, Sen. Oct. 23) W. Bentall; (Nov. 11, Sen. Oct. 29) V. I. C. A. Pall; (Nov. 11, Sen. Oct. 30) H. W. Cooper; (Nov. 13, Sen. Oct. 31) G. W. Dodds. Pilot Officers on probation. Warrant Officers:—(Nov. 1, Sen. Oct. 25) D. McDermott; (Nov. 5, Sen. Oct. 21) L. Welch; (Nov. 5, Sen. Oct. 24) A. W. Darnell; (Nov. 7, Sen. Oct. 28) L. Morgan; (Nov. 11, Sen. Oct. 29) R. Darker (Nov. 11, Sen. Oct. 31) E. Roberts; (Nov. 12, Sen. Oct. 24) W. L. Weager, F. P. Gardiner, Walker; (Nov. 6, Sen. Oct. 21) C. H. R. McNally; (Nov. 6, Sen. Oct. 22) L. E. King; (Nov. 11, Sen. Oct. 22) E. D. Bath; (Nov. 13, Sen. Oct. 25) P. A. Heppell.

The undermentioned Flying Officers are confirmed in their appointments:—(Oct. 15) A. T. Jones, M.M., H. L. Whitlock; (Oct. 30) G. O. Thomson.

Administrative and Special Duties Branch.

The undermentioned are granted commissions for the duration of hostilities:—Flying Officers on probation. Warrant Officers (Oct. 28, Sen. Oct. 15) A. F. Germain; (Nov. 6, Sen. Oct. 21) W. D. Colcman, M.B.E.; (Nov. 11, Sen. Oct. 23) J. K. McK. Semple. Pilot Officers on probation. Warrant Officers:—(Oct. 28, Sen. Oct. 10) F. W. H. Ainsworth; (Oct. 28, Sen. Oct. 11) M. P. Croft; (Oct. 28, Sen. Oct. 7) F. E. Dudley; (Oct. 28, Sen. Oct. 8) F. H. Pratt, F. J. Rowe; (Oct. 28, Sen. Oct. 9) W. Lawry, A.F.M.; (Nov. 6, Sen. Oct. 21) F. S. Turner; (Nov. 14, Sen. Oct. 29) T. H. Elliott. Flight Sergeants:—(Oct. 22, Sen. Oct. 1) J. B. Hay; (Oct. 23, Sen. Oct. 4) J. Colquhoun; (Oct. 25, Sen. Oct. 4) L. G. Chapman. Sergeants:—(Nov. 6, Sen. Oct. 21) C. W. Martin; (Nov. 11, Sen. Oct. 24) R. C. Spicer. Corporal:—(Oct. 14, Sen. Aug. 30) E. S. Alexander. Leading Aircraftman:—(Oct. 30, Sen. Oct. 14) C. M. V. Hamilton.

Equipment Branch.

F/O. on probation G. R. C. Baker is confirmed in his appointment. (Oct. 20.)

P/O. on probation J. T. Cramb is promoted to the rank of Flying Officer on probation (Sept. 15.)

The undermentioned Pilot Officers on probation are confirmed in their appointments (Aug. 17), and promoted to the rank of Flying Officer:—(Oct. 14) R. J. Tilley; (Oct. 15) R. O. Snape; (Oct. 25) P. J. Finn; (Oct. 31) C. S. Hatfield.

Accountant Branch.

Cpl. P. C. Dainty is granted a commission for the duration of hostilities as Acting Pilot Officer on probation. (Nov. 1, Sen. Oct. 10.)

The short service commission of Pilot Officer on probation W. Buckley is terminated on cessation of duty. (Nov. 24.)

Pilot Officer on probation A. Moorcroft is confirmed in his appointment (July 29) and promoted to the rank of Flying Officer. (Sept. 7.)

Erratum.

In notification of Sept. 13 concerning Sgt. W. R. E. Wilson. *For* Aug. 24 *read* Aug. 26.

Medical Branch.

Flt. Lt. R. S. Peill, M.B., Ch.B., is granted a permanent commission in the substantive rank of Flight Lieutenant. (Sept. 2.)

Royal Air Force Reserve

RESERVE OF AIR FORCE OFFICERS.

General Duties Branch.

The undermentioned Flying Officers are promoted to the rank of Flt. Lt.:—(Sept. 3, 1939) G. F. Hales; (Sept. 3) C. E. F. Riley; (Sept 8) K. C. Jackman; (Sept. 14) W. S. Coates; (Sept. 25) W. R. Bailey; (Nov. 6) R. M. Pimm; Nov. 15) D. W. Law; (Nov. 25) R. B. Crow; (Nov 30) H. Swanston, A. S. Gilbert.

The undermentioned relinquish their commissions in Class CC on appointment to commissions in the R.A.F.V.R.:—(Sept. 1, 1939) Flt. Lt. R. S. Barbour; (June 18) Sq. Ldr. H. V. Smith.

P/O. E. R. Bowman resigns his commission (Nov. 15).

The notifications of April 30 and May 7 concerning R. S. Barbour are cancelled.

The notification of Aug. 27 concerning F/O F. W. Moss is cancelled.

Erratum.

In notification of Oct. 4 concerning P/O. on probation R. W. Edward. *For* Sept. 26 *read* Nov. 30.

Equipment Branch.

Pilot Officer on probation J. Bayliss is confirmed in his appoin ment July 7, and promoted to the rank of Flying Officer Oct. 30.

Erratum.

In notification of Oct. 22 concerning F/O. D. A. Watson. *For* F/O. *read* Flt. Lt.

Royal Air Force Volunteer Reserve

General Duties Branch.

The undermentioned are granted commissions for the duration of hostilities. As Flying Officer: (Nov. 12) C. J. McN. Bowie. As Pilot Officers on probation: (Nov. 14) W. G. T. Brown. Sergeants. (Aug. 25) G. N. Bales, J. R. C. Bennet; (Sept. 29, Sen. Sept. 18) R. A. C. Holme; (Oct. 2, Sen. Sept. 29) M. J. Smith; Oct. 10, Sen. Oct. 2) T. Birkett; (Oct. 19) C. C. Cheshire, J. S. B. Tyrie; (Oct. 24, Sen. Oct. 23) E. A. Hood; (Oct. 31, Sen. Oct. 23) W. C. Carswell; Nov. 4, Sen. Oct. 30) R. P. Stevens; (Nov. 6, Sen. Oct. 30) L. S. Pilkington, D.F.M.; (Nov. 7, Sen. Oct. 30) L. C. Arthur; (Nov. 8, Sen. Oct. 23) A. J. W. Males; (Nov. 9, Sen. Oct. 29) H. T. Jones; (Nov. 11, Sen. Nov. 3) P. J. A. Thompson; (Nov. 16, Sen. Aug. 9) M. R. Aries; (Nov. 15, Sen. Oct. 27) J. E. Smith, A. Sumner; (Nov. 16, Sen. Nov. 2) H. G. Craigmile; (Nov. 16, Sen. Nov. 7) M. Littlewood. Leading Aircraftmen: (Nov. 3) E. B. Benson, A. F. Struthers, G. T. Thain, R. Vevers, J. H. Waite; (Nov. 4, Sen. Oct. 27) M. F. Andrews; (Nov. 9, Sen. Oct. 29) H. A. Williams; (Nov. 9, Sen. Nov. 3) P. Jack; (Nov. 16, Sen. Oct. 27) J. A. F. Sowrey; (Nov. 16, Sen. Nov. 2) A. B. Broadley, J. F. Slatter; (Nov. 16, Sen. Nov. 3) E. H. Atkins, L. G. Bedford, C. A. Blackburn; (Nov. 16, Sen. Nov. 7) T. Maxwell-Hudson, T. C. Richards, W. McN. Spiers, R. E. Tidswell, C. F. C. Ward, W. A. R. Keddie; (Nov. 17, Sen. Nov. 7) T. M. Gay, J. L. Griffiths, P. P. Villa. As Act. Pilot Officers on probation: (March 4) J. H. Hoare-Scott, D. M. Ryan; (July 17) J. Roberts (substituted for notification of Sept. 13 under the heading Administrative and Special Duties Branch); (July 26) A. E. Mills; (Nov. 2) W. H. Thomas.

The undermentioned Pilot Officers on probation are confirmed in their appointments and promoted to the rank of Flying Officer:—(Sept. 27) J. P. B. Almack; (Oct. 1) S. F. Preston; (Oct. 2) C. L. Elliott; (Nov. 23) W. C. Potter.

The undermentioned Act. Pilot Officers on probation are graded as Pilot Officers on probation:—(Aug. 31) S. Body; (Nov. 3) H. A. De Freitas.

The undermentioned Flying Officers are promoted to the rank of Flight Lieutenant:—(Sept. 3) J. H. C. Beard, K. W. Hole, R. Bennett, D. M. Walbourn, E. M. Webb; (Sept. 4) C. G. B. McClure; (Sept. 9) A. J. Sayer; (Sept. 18) R. Rendle.

The undermentioned Pilot Officers are promoted to the rank of Flying Officer:—(Sept. 4) J. E. Jackson; (Sept. 18) R. C. Hockley; (Sept. 25) J. G. Forbes, W. J. Searle, A. G. Evill, B. C. Pargeterr, E. G. Hughes, A. G. A. Fisher; (Sept. 26) H. Arnott, C. H. Bacon, J. R. A. Bailey, J. J. F. H. Bandinel, I. N. Bayles, P. R-F. Burton, A. E. Cook, H. H. Eccles, J. L. Halstead, W. R. A. Knocker, T. H. A. Llewellyn, M. J. P. Martin, P. F. Mayhew, J. R. H. Merifield, G. H. N. Edwards, R. P. C. Thompson, D. Warburton; Oct. 31 C. A. Alldis, T. P. E. Barlow, J. Brotherton-Ratcliffe, A. Bulmer, J. A. G. Coates, E. D. C ew, R. F. Dent, D. J. Dunn, W. L. Ellingham, R. G. Furness, R. A. V. Gascoyne-Cecil, R. H. Gordon, R. V. L. Griffiths, I. S. Haggie, A. W. Hirons, F. D. Hughes, E. W. Lindsay, J. Lockhart, P. F. Mallender, J. C. Mclvill, H. T. Morgan, J. L. Nunn, A. G. Page, R. C. Parker, H. H. Percy, D. Petley, J. C. E. Robinson, J. W. Seddon, J. G. R. Sturrock, R. L. Tanner, A. B. Tisdall, R. P. Turner, N. R. Wheatcroft, R. S. Woodward; (Nov. 26) T. G. F. Ritchie.

Pilot Officer on probation M. Luczkow resigns his commission (Nov. 10).

The notification of Sept. 27 concerning P/O. G. H. Goodman is cancelled.

Erratum.

In notification of Oct. 4, *for* B. Grimston *read* The Hon. B. Grimston.

Technical Branch.

The undermentioned are granted commissions for the duration of hostilities as Pilot Officers on probation:—Sergeant: (Sept. 6, Sen. May 30) S. L. Hill. Corporal (Nov. 2, Sen. Oct. 9) D. G. Sainsbury.

Pilot Officer on probation E. M. Hook is confirmed in his appointment (Oct. 19).

Pilot Officer on probation R. D. Poore is confirmed in his appointment and promoted to the rank of Flying Officer (Nov. 22).

Balloon Branch.

The undermentioned are granted commissions for the duration of hostilities as Pilot Officers on probation:—Flight Sergeant: (Nov. 8, Sen. Oct. 22) L. S. Prosser. Corporals: (July 3, Sen. June 25) A. G. Goode; (Aug. 24, Sen. Aug. 6) R. J.

SERVICE AVIATION (CONTINUED)

Rhodes; Oct. 22, Sen. Oct. 7) W. W. Green; (Oct. 30, Sen. Oct. 11) E. H. N. Brecze; (Nov. 8, Sen. Oct. 21) A. Stevens; (Nov. 8, Sen. Oct. 22) D. S. Boyle, J. I. Williamson; (Nov. 11, Sen. Oct. 22) V. G. Biller. Leading Aircraftmen: (Sept. 20, Sen. Sept. 5) L. J. Gooch; (Nov. 8, Sen. Oct. 22) A. L. L. Evans; (Nov. 9, Sen. June 24) G. E. Thomas. Aircraftmen 1st class: (Oct. 22, Sen. Oct. 7) S. de P. Gauvain; (Oct. 31, Sen. Oct. 11) J. P. H. Jacobs; (Nov. 7, Sen. Oct. 21) P. H. Kerslake; (Nov. 11, Sen. Oct. 22) E. J. Fitz-Gerald, D. M. Mackusick. Aircraftmen 2nd class: (July 3, Sen. June 25) R. S. Ridgway; (Nov. 9, Sen. Oct. 22) A. L. Thompson.

Act. Pilot Officer on probation K. M. Buckley is graded as Pilot Officer on probation (Aug 31).

Administrative and Special Duties Branch.

The undermentioned are granted commissions as Flight Lieutenants:— (Sept. 1, 1939, Sen. Dec. 16, 1935) Sq. Ldr. R. S. Barbour (R.A.F.O.); (June 18) Lt. H. V. Smith, D.C.M. (R.A.R.O.); (Nov 22) Major K. M. Ball, D.S.O., R.A. (Ret.).

The undermentioned are granted commissions for the duration of hostilities: As Flying Officer: (Sept. 24, Sen. Sept. 1, 1939) J. E. M. Atherley (substituted for notification of Nov. 5, 1940, concerning this officer). As Pilot Officers on probation: (June 28) T. H. Brown, H. E. Morris; (June 29) P. A. Calton, T. A. Lyon, E. V. Todd; (July 17) R. Gilroy; (July 27) J. Cassells (substituted for notification of Aug. 20 concerning this officer), A. F. Tabraham; (Aug. 26) D. A. Pope; (Sept. 16) R. R. Barber (substituted for notification of Oct. 22 concerning this officer); (Sept. 21) C. B. Boughton (substituted for notification of Oct. 15 concerning this officer); (Sept. 23) B. Ward; (Sept. 30) N. C. Mackenzie; (Oct. 3) C. T. Robinson; (Oct. 5) F. G. Bird; (Oct. 7) C. A. Mackay; (Oct. 15) N. J. Tuck; (Oct. 16) J. J. Curnow; (Oct. 18) R. E. Salvesen; (Oct. 19) G. Hathorn; (Oct. 21) P. Higson, B. Webb; (Oct. 22) O. P. Ladyman, W. E. McVicar, C. D. Stephenson; (Oct. 25) W. D. Annan, H. E. Arnholz, F. W. Arnold, B. J. Boland, W. H. Bontoft, I. T. Bowen, F. Bowles, D. V. Briggs, N. W. Broughton, R. C. Chalk, G. Collinson, A. H. L. Cooper, A. L. Franks, A. Garden, A. E. R. Gilligan, G. P. Grieve, J. W. Gurstone, P. T. Hammond, H. A. Hardman, R. A. Harrison, L. I. Hewitt, C. G. Hutchings, J. C. N. Kilner, H. C. Lawrence, R. H. M. Macdonald, J. A. Mason, J. McGibbon, G. E. Meredith, J. N. Owen, J. A. Pitcher, A. S. G. Robertson, J. B. Robinson, T. McD. B. Russell, G. P. Scott, R. Scourfield Evans, J. C. W. Seex, A. C. Sherborne, J. Shillinglaw, F. W. C. Smith, J. H. Smith, E. St. John, B. Thomas, A. W. Trotter, H. J. Truett, E. Westlake-Guy, P. H. F. White-Gall, H. Wilkinson, A. S. Williams, J. P. Young; (Oct. 26) E. Davies, M. F. P. Lubbock; (Oct. 29) E. J. Matthews, Viscount I. B. Ratendone; (Nov. 1) A. d'Agapeyeff, G. W. Bain, R. Beeching, H. A. Bohane, G. L. Bond, H. Brown, H. Coleman-Smith, A. E. S. Cooper, L. Cox, E. V. Cunliffe, H. C. Debenham, J. T. De Fraine, J. R. De La Mare, R. H. Dobbie, G. M Donner, A. H. Duggan, W. T. Elverston, V. D. O. Ezekiel, F. L. Fox, J. H. Griffith-Williams, B. W. Gunn, J. A. L. Henderson, A. Henry, E. M. F. Hudson, W. L. Ives, G. Kennard, S. A. Khan, J. T. L. Mallard, J. V. Mulholland, T. Sandilands, K. M. Scamell, G. D. Shand, C. Shaw, B. B. Smith, W. J. Voisey-Youldon, J. K. R. Walker, G. A. Welfear, P. D. Whitting, P. Whyte, R. W. Willmer; (Nov. 5) A. D. Bovill, G. A. Capes, F. J. Levens, A. J. Perry, P. E. C. Romney; (Nov. 6) G. Stott; (Nov. 7) J. G. Browning, W. B. Home-Gall, A. N. MacGill, D.C.M.; (Nov. 8) J. T. Agelasto, N. A. Argenti, A. Armitage, E. J. Bannister, W. B. Davies, F. R. Derry, A. Donaldson, E. F. Drew, A. W. Eves, J. D. Farmiloe, G. D. Gardner, M.C., W. C. Green, O. Hailstone, B. Hale, A. F. Hamilton-Smythe, L. Hartley, D. J. T. Henderson, L. N. Higgins, K. P. H. Hunt, W. Jamieson, E. D. Jones, J. B. C. Lamburn, J. S. Leslie, J. MacDonald, H. McClunan, D. H. Mills, R. C. Milne, T. J. Moffatt, P. O'Dwyer, K. A. L. Offord, F. W. Quiggin, E. A. B. Radford, G. Rees, P. M. Rogers, W. J. B. Saunders, E. S. Shapley, N. S. Smith, P. L. Stephens, E. Swan, I. V. Thomas, W. S. Thomas, R. A. Trevenen, C. M. G. Wallwork, F. C. White, R. C. White, W. Wilkinson, G. C. Willis, R. J. Woodroffe; (Nov. 9) C. T. Anderton, T. H. Bent, A. J. Booth, L. R. Brass, C. W. A. Brown, W. M. Christie-Miller, A. Duncan, J. M. Farquhar, W. L. Fleming, A. Fraser, R. H. F Godley, F. E. Greenwood, L. M. Hanbury-Bateman, A. A. Harley, R. B. Hirsch, E. W. Hitchings, J. V. M. Howe, F. C. Jackson, A. L. Jones, J. C. B.-W. Leonard, J. E. L. Lewington, D. J. Lown, E. H. Maddick, A. E. Matthew, W. W. Mitchell, J. W. Morgan, P. L. Murphy, T. G. Noble, A. G. Oliver, R. B. Oliver, A.-S. Ostens, R. S. Rowlands, A. F. L. Smith, C. T. Smith, R. F. Sutherland, W. Thomas, J. W. Troughton, N. J. L. Weir, E. C. Wheatley, N. Wild, P. E. Wilder, A. R. N Wilkinson, E. L. Worthington; (Nov. 13) V. A. Loftus-Paton; (Nov. 18) E. C. Allen, R. E. Cole, R. S. Courtney, A. K. Davenport, E. Eden, J. S. Kay, P. S. T. Kingdon, W. E. Plummer, H. P. Pollard, A. C. Smith, D. N. Thomas Serjeants: (Oct. 17, Sen. Sept. 26) B. B. Braunston; (Nov. 11, Sen. Aug. 30) R. Foulkes. Corporals: (Nov. 5, Sen. Oct. 15) C. Mepham, (Nov. 11, Sen. Oct. 17) J. L. Burness. Leading Aircraftmen: (Oct. 24, Sen. Sept. 19) D. M. Dent; (Nov. 4, Sen. Sept. 20) R. V. Quye. Aircraftmen 2nd Class: (Nov 5. Sen. Oct. 24) R. S. Scrivener; (Nov 8 Sen. Oct. 14) P. E. W. Gellatly; (Nov. 8. Sen. Oct. 28) E. H. Lush.

The undermentioned Pilot Officers on probation are confirmed in their appointments: (Sept. 9) J. D. Bowman, E. Brewer, C. G. Wood; (Sept. 19) H. G. Hudson, A. G. Mower, H. A. B Robb, M.C., A.F.C., W. H. Thomas, C. Volk, H. Williamson, S. J. Wines; (Sept. 26) C. L. Blake, F. Carr, A. H. Day, D.F.C., H. Entwisle, W. H. Gibson, A. G. Harrison, J. Jameson, A. W. Robinson, J. J. B. Rutter, F. C. Staines, S. L. Symondson, R. F. E. Wickham; (Oct. 7) J. S. Hodges; (Oct. 8) F. L. Wills; (Oct. 10) W. F. Willis; (Oct. 12) M. P. Dalrymple; (Oct. 18) S. G. Frogley, D.S.O., D.F.C.; (Oct. 23) C. O. Powis; (Oct. 24) T. G. Whitlock, C. M. Horsfall; (Oct. 25) H. V. Stammers, D.F.C., V. E. R. Blunt, G. H. L. Easterbrook; (Oct. 28) C. H. A. A. A. Hankey; (Oct. 30) B. W. Dalrymple, W. P. Stewart, D.S.O.; (Nov. 3) H. F. Payne; (Nov. 4) S. D. Harrower; (Nov. 5) J. D. Irving, O.B.E., M.C.; (Nov. 6) L. C. Mein; (Nov. 7) M. J. C. Allom; (Nov. 8) R. D. A. Clowes; (Nov. 17) C. C. Cholmondeley; (Nov. 20) Rt. Hon. W. G. H. W. Lord Waleran.

The undermentioned Pilot Officers on probation are confirmed in their appointments and promoted to the rank of Flying Officer: (Sept. 9) L. H. R. Lewis; (Sept. 12) C. S. Emden, D.F.C.; (Sept. 19) S. Buckenham, C. A. Mackenzie, H. J. Pritchett, H. Sacre, E. B. Thomson; (Sept. 26) M. E. Bradley, L. E. Crawley, W. G. Foulds, S. E. Rowley; (Oct. 3) R. H. Esencourt; (Oct. 10) F. J. F. Smythe; (Oct. 11) J. A. Livingston; (Oct. 16) L. C. Saxby, M. B. Smith; (Oct. 18) L. F. Hutcheon, A.F.C., W. H. F. Brunskill; (Oct. 23) T. H. Newsome; (Oct. 24) A. V. Collins; (Oct. 25) G. J. Mapplebeck, E. C. Ormonde, E. C. Owens; (Oct. 30) L. Bertrand; (Nov. 13) A. Amato Gauci, J. E. S. Long; (Nov. 21) G. H. Wass.

Act. Pilot Officer on probation J. P. Turtle is graded as Pilot Officer on probation (July 22) (substituted for notification of Oct. 8).

The undermentioned Pilot Officers on probation are transferred to the Technical Branch: (April 24) P. P. Love; (July 25) L. J. Fowler.

The undermentioned officers are transferred to the Balloon Branch (Mar. 27): Flying Officers: Lord Ventry. Pilot Officers: J. Molesworth-St. Aubyn, J. B. Watson, D. Ross, H. S. Hargreaves, L. N. Henderson, L. S. Duffill, E. Lyon, R. W. Beresford, E. G. Pole, F. J. Ainge.

The undermentioned resign their commissions: Flying Officers: (Nov. 20) H. E. Twaits; (Nov. 28) F. H. Murray. Pilot Officer: (Nov. 9) S. A. Dismore. Pilot Officer on probation: (Nov. 20) S. E. Schofield.

The commissions of the undermentioned Pilot Officers on probation are terminated on cessation of duty: (Nov. 19) H. Parker, J. S. Stacey; (Nov. 22) C. T. Maclaren, G. N. Thompson, G. R. Turner; (Nov. 26) W. F. R. Boardman.

Errata.

The notification of November 5 concerning D. C. A. McPherson is cancelled.

In notification of August 13 concerning P/O. on probation W. A. Lane. *For* July 31 *read* August 1.

The notification of October 29 concerning the undermentioned should have appeared under the heading of "R.A.F." and not "R.A.F.V.R.": Warrant Officer R. S. Sweetlove, Flt. Sgt. R. Mallett, Flt. Sgt. H. C. F. Fletcher, Flt. Sgt. A. S. Flatters, Cpl. G. A. P. Duby.

Equipment Branch.

C. J. V. Gray is granted a commission for the duration of hostilities as Act. P/O. on probation (Sept. 16).

P/O. on probation W. E. Hole is confirmed in his appointment (Nov. 13).

The undermentioned Pilot Officers on probation are confirmed in their appointments (Sept. 18), and promoted to the rank of Flying Officer (Nov. 19): E. A. Bradly, T. W. James, J. B. Jeves, F. J. W. Knowles, A. L. Mitchell, P. E. Wilson.

P/O. on probation A. L. Scull is confirmed in his appointment (Sept. 9), and promoted to the rank of Flying Officer (Nov. 24).

The undermentioned Acting Pilot Officers on probation are graded as Pilot Officers on probation: (July 24) D. R. Paine; (July 30) H. F. G. Tristam.

Accountant Branch.

L.A/C. E. R. H. Scott is granted a commission for the duration of hostilities as Acting Pilot Officer on probation (Nov. 1, Sen. Oct. 10).

The undermentioned Acting Pilot Officers on probation are graded as Pilot Officers on probation: (Sept. 21) C. Manson; (Oct. 11) H. A. Barnes, G. S. Batten, H. McG. Berry, H. Booth, J. C. C. Brain, W. E. Brooke, C. A. Butt, D. H. P. Cannon, A. C. E. Caplen, R. J. Clough, H. S. Coley, C. B. Cross, A. W. Deacon, S. L. Drew, J. B. Fleming, F. Green, H. A. Haire, S. T. Hawes, M. F. Hickman, E. H. Kemp, D. G. Kershaw, H. Lucas, C. D. Mactaggart, F. E. Main, C. H. Mears, N. Roberts, K. C. Robins, S. F. Rogers, G. J. Sellers, H. J. Smethurst, G. T. Smith, H. G. Swindells, E. Thompson, T. H. Trump, N. A. Tye, W. R. Ward, A. Whiteley, J. H. Worrall, C. S. Elphinstone, A. S. Clarke, J. E. Jenkins.

Medical Branch.

The undermentioned are granted commissions for the duration of hostilities:—As Squadron Leader: (Nov. 8) A. G. Palin, B.M., B.Ch., M.R.C.S., L.R.C.P., F.R.C.S. (E). As Flight Lieutenants: (Nov. 5) R. G. E. Richmond, M.R.C.S., L.R.C.P., J. B. Shield, M.B., Ch.B., F.R.C.S. (E). As Flying Officers: E. Anthony, M.R.C.S., L.R.C.P., O. H. E. Bayles, M.R.C.S., L.R.C.P., F. W. Belford, M.B., Ch.B., P. J. Connolly, M.B., Ch.B., D. A. Craib, M.B., Ch.B., G. M. Evans, M.R.C.S., L.R.C.P., D. A. Ferguson, M.B., B.S., M.R.C.S., L.R.C.P., W. H. Galloway, M.B., Ch.B., W. Gordon, M.B., Ch.B., B. S. Grant, M.B., B.S., M.R.C.S., L.R.C.P., C. O. Greer, M.B., B.Ch., R. S. Holgate, M.B., Ch.B., D. M. Kelleher, M.B., B.Ch., H. Kenyon, M.B., Ch.B., F. D. MacCarthy, M.R.C.S., L.R.C.P., R. R. McSwiney, M.B., B.S., M.R.C.S., L.R.C.P., H. Silverman, M.B., Ch.B., D. McG. Simpson, L.R.C.P. and S., L.R.F.P.S., N. Stephen, M.R.C.S., L.R.C.P., R. G. MacL. Wedderburn, M.B., Ch.B., W. P. Weir, M.B., Ch.B.

Erratum.

In notification of Oct. 4 concerning I. H. Gossett. *For* Gossett *read* Gosset.

Dental Branch.

The undermentioned are granted commissions for the duration of hostilities as Flying Officers: (Nov. 5) H. G. J. Griffiths, L.D.S., N. A. Hawkins, L.D.S., F. S. Krusin, B.D.S., M.R.C.S., L.R.C.P., I. H. J. Morgan, L.D.S., H. J. Phillips, D.D.S., L.D.S., R. G. Siggers, L.D.S.

The undermentioned Flying Officers are promoted to the rank of Flight Lieutenant: (July 18) H. C. Davis, L.D.S., R.C.S. (Eng.); (Oct. 16) W. R. Williams, L.D.S.; (Oct. 23) T. D. H. Millar, L.D.S., M. Malleson, L.D.S.

Chaplains Branch.

The undermentioned are granted commissions for the duration of hostilities with the relative rank of Squadron Leader: (Nov. 12) The Rev. E. A. Buchan, B.A.; (Nov. 19) The Rev. S. W. A. Collins, The Rev. R. F. Diggle, The Rev. C. E. G. Jones, The Rev. H. J. J. Harries, M.A., The Rev. F. L. Trewella, B.A.

Auxiliary Air Force

General Duties Branch.

The undermentioned Flying Officers are promoted to the rank of Flight Lieutenant: (Nov. 13) J. C. Barclay; (Nov. 24) G. N. S. Cleaver, D.F.C.

F/O. P. G. M. Hancock is transferred to the Administrative and Special Duties Branch (Nov. 25).

The undermentioned are transferred to the Administrative and Special Duties Branch (Mar. 27): Squadron Leader: J. E. D. Benham. Flight Lieutenant: T. R. Bird. Flying Officers: The Earl of Eldon, A. M. Makepeace. Pilot Officer: E. S. Riley.

Balloon Branch.

F/O. G. A. Mitchell is transferred to the Administrative and Special Duties Branch (Nov. 26).

Administrative and Special Duties Branch.

P/O. P. Reeves is promoted to the rank of Flying Officer (Sept. 3).

Auxiliary Air Force Reserve of Officers

General Duties Branch.

F/O. P. B. Robinson relinquishes his commission on account of ill-health (Dec. 3).

Balloon Branch.

The transfer of the undermentioned to the Balloon Branch effected by the omnibus Gazette notification of Aug. 20 is cancelled:—Squadron Leaders: J. E. D. Benham (A.A.F.), E. S. C. Grune (R.A.F.V.R.). Flight Lieutenants: T. R. Reid (A.A.F.), E. W. Carmichael (R.A.F.V.R.), G. M. Johnstone (R.A.F.V.R.), W. P. Lewis (R.A.F.V.R.), F. W. Carryer (R.A.F.V.R.), G. T. Stoneham (R.A.F.V.R.), J. D. McEwen (R.A.F.V.R.). Flying Officers: The Earl of Eldon (A.A.F.), A. M. Makepeace (A.A.F.), A. R. Hind (A.A.F.), E. J. D. Ettwell (A.A.F.), R. E. Stephens (R.A.F.V.R.). Pilot Officers: R. C. Hawkins (A.A.F.), E. F. Tanner (A.A.F.), T. Rowley (A.A.F.), H. J. Cuff (A.A.F.), W. J. Amlot (A.A.F.), C. B. Hardy (A.A.F.), L. G. Mobsby (A.A.F.), C. P. Bennett (A.A.F.), H. Clayton (A.A.F.), R. H. Burdon-Cooper (A.A.F.), E. H. Lee (A.A.F.), J. F. Venner (A.A.F.), P. B. Doorly (A.A.F.), H. S. Thomas (A.A.F.), G. Gravrigue (A.A.F.), A. B. Gillespie (A.A.F.), L. Mackintosh (A.A.F.), F. Haworth (R.A.F.V.R.), E. S. Riley (A.A.F.), A. R. Cousins (A.A.F.).

The undermentioned, who were not included in the June Air Force list, are to be considered as transferred to the Balloon Branch (Mar. 27). (See notification of Aug. 20):—Flying Officers (since promoted): (Mar. 27) H. Macfarlane, F. N. Adlington. Pilot Officer: (May 15) F. J. Kershaw.

Women's Auxiliary Air Force

The undermentioned are appointed Assistant Section Officers: (Nov. 20) Cpl. Miss A. D. Anderson, Cpl. Miss M. E. Baker, Cpl. Miss D. M. Barton, Sgt. Miss E. O. Clark. A/CW.1 Miss R. F. E. Davies, A/CW.2 Miss K. L. Downs, Cpl. Mrs. B. B. Emerson. A/CW.2 Miss P. G. Hollick, A/CW.1 Miss M. M. Hunter, A/CW.2 Miss M. A. Keith, Cpl. Miss E. E. Marks, Cpl. Miss E. E. Marlow, A/CW.2 Miss D. Norwood, A/CW.2 Mrs M. A. Pateman, Sgt. Miss J. M. Roffey, A/CW.2 Mrs. Selby, Sgt. Miss I. F. Stone, Sgt. Miss K. Veitch, A/CW.2 Miss M. Wilson, Sen. Sgt. Miss K. M. Wysard: (Nov. 23) A/CW.2 Miss D. A. Bliss, A/CW.1 Miss P. J. S. B. Dance, A/CW.1 Miss D. M. De Sausmarez, A/CW.1 Miss P. Grey, A/CW.1 Miss T. J. Horley, Cpl. Miss P. J. Martin, A/CW.1 Mrs. M. E. Pawsey, A/CW.2 Miss R. V. Robinson, A/CW.2 Mrs. V. G. Sherring, Cpl. Miss J. Tomkin, A/CW.1 Miss S. Wiles, A/CW.1 Miss R. Young.

The undermentioned relinquish their appointments: (Oct. 23) F/O. Miss D. Moon; (Nov. 15) S/O. Mrs. V. Crosland; (Oct. 6) Assist. S/O. Miss B. A. Ralphs; (Nov. 5) Assist. S/O. Mrs. E. H. Johnson; (Nov. 18) Assist. S/O. Miss D. M. M. Whuddett; (Nov. 19) Assist. S/O. Mrs. D. E. Yates.